Des Barker test flies the

PACIFIC AEROSPACE CT-4E AIRTRAINER

THE COST of training a military pilot to "Wings standard" is exorbitant (typically R4-million of taxpayer's money) because of the wide range of skills that must be taught and developed.

Military pilots are, first of all, combatants, and must be able to use an aircraft in military operations under all weather conditions, by day or by night.

The suspension of cadet pilots from training is fruitless expenditure and all efforts must thus be incorporated to cut losses, including the use of a suitable *ab initio* trainer.

Military pilot selection criteria obviously requires a rather rigorous selection process of "battery tests" including very strict medical entrance criteria, aptitude tests and psycho-motor tests to ensure that the aspirant pilot will be able to deal with the challenges, both military and psychological, of military operational flying.

An applicant must undergo written aptitude tests, coordination/motor skills tests, interviews with psychologists and finally, a selection board manned by a team of experienced specialists. The objective at this point is to screen out applicants who are medically unfit, or suffer personality disorders which would make them unsuitable for the military.

If the applicant has failings in any of these areas, they may not become apparent until well into the training process, resulting in a washout, grief to the failed applicant who has by then a much greater personal investment in the process, and last, but not least, taxpayers' money expended.

Upon closer examination, however, it is clear that a snapshot over a period of several hours of interviews is unlikely to provide a very deep insight in the applicant – qualities such as tenacity under pressure and the ability to coordinate and prioritise tasks under pressure in flight, remain at this point, unknowns, their presence or absence assessed only in the subjective estimates of the officers on the selection panel.

The final phase of the military pilot assessment process, then, is *ab initio* flight training. It is all very well to have a number of physical and mental "test batteries ", which are not full proof indicators of an aspirant pilot's ability to meet the challenges of military flying. The only proof of the cadet's true potential, is to assess him or her in the actual flight environment in a suitable aircraft that will enable an instructor to assess and make the call on the cadet's potential to graduate with military wings.

The objective of such meticulous scrutiny of the cadet pilot is to improve the probability of the cadet pilot being able to operate an aircraft safely within the military environment. However, the critical element to evaluate the cadet's capabilities is dependent on the type of aircraft used during the *ab initio* phase; it must measure the correct fundamentals required to "build a military pilot".

MILITARY PILOT TRAINING

For very good reasons, military recruitment and training mechanisms are very different from their civilian counterparts, due mainly to the fundamentally different environment within which military pilots must function.

Military pilots must demonstrate not only a high standard of airmanship flying high performance aircraft, but must also be able to function in hostile airspace under the pressure of very high pilot workload.

To this must be added the tactical skills relating to the application of the aircraft's offensive and defensive systems.

Cognitive saturation by information is a fundamental issue in this environment and the military pilot must therefore have a proven capacity to handle the aircraft effectively while being bombarded with stimuli from navigation / weapon systems and threat warning sensors.

This places much higher demands upon the pilot's ability to cope with workload on sorties, but also demands individuals with the ability to handle very steep learning curves. So, what are the qualities required of an ideal military ab initio trainer?

AB INITIO MILITARY TRAINER

An *ab initio* trainer aircraft should therefore be designed specifically to facilitate in-flight training of military pilots. More particularly:

- It must provide a platform from which an instructor can gauge the potential of the cadet to succeed along the military training path and syllabus and deal with the challenges of using an aircraft as a fighting vehicle.
- It should enable the instructor to assess the cadet's ability to deal with pilot workload during the various phases of basic flight training, psychomotor skills, judgement, and resilience.
- Additional features to enhance the teaching process include dual flight controls, forgiving flight characteristics, simplified cockpit arrangement, allow pilots-in-training to safely advance their real-time piloting, navigation and/or war-fighting skills without the danger of overextending their abilities.
- At least provide all the basic flight instrumentation in which the basics of handling and airmanship can be taught.
- The performance and handling qualities, must provide a balance between pilot workload and military aircraft "feel"; one that is capable of stall and spin characteristics that will enable the cadet pilot to develop psychomotor skills in controlling the aircraft about all axes. Contrary to modern civilian aviation standards, military pilots are taught to be able to handle the aircraft confidently throughout the entire flight envelope, including accelerated stalls, deep stalls, departures, spins, erect and in some cases, inverted, and
- Sufficient excess power to provide a wide enough speed range to enable the aircraft to conduct aerobatics, instrument flying exercises and basic navigation, effectively.

As a teaching platform, it is very important for the instructor to be able to monitor what the cadet is actually doing with his hands and feet, where he is looking, how and when he trims, in fact, to actually see if the cadet understands the instructions through his physical response and behaviour.

Other enhancing features include good visibility, particularly of the horizon, the ability to simulate in-flight emergencies, logical and intuitive cockpit ergonomics and "switch-ology", ruggedness both in-flight and on the ground to the vagaries of cadet handling/mishandling.

The performance and handling qualities must provide a logical and appropriate step to the next tier of basic training aircraft, and last, but not least, operating cost and maintenance.

All photographs by Mark Mansfield

ENTER THE CT-4E

ENTER THE CT-4E AIRTRAINER IN AFRICA

The Pacific Aerospace CT-4E AirTrainer is a two side-by-side seater, single engine, low wing, all metal monoplane with fixed tricycle under-carriage cleared for IFR operations and already in service with the Royal New Zealand Air Force, the Royal Australian Air Force and the Thai Air Force.

This is an aircraft which recently appeared on the African aviation scene. It has been imported into South Africa by Wonderboom Airport, Pretoria-based AirTeam Aviation, and ideally meets the strict requirements of military flight training on the one hand, and also makes an ideal civilian trainer on the other, as has been found in the Pacific Region.

AirTeam Aviation is planning an extensive tour of African states to introduce the aircraft to the various air forces.

The CT-4E's 300 hp Lycoming engine and three bladed propeller combine to provide an aircraft that, to date, has demonstrated the ability to challenge the cadet pilot while also being a forgiving platform that can be used to train military *ab initio* pilots.

For the *ab initio* training role, it provides the essential performance features which must extract the maximum tuition time per hour slot and typically includes short takeoff and landing distances, high excess power available for quick time-to-height and rapid acceleration capability and last, but not least, good specific air range, for range and endurance.

Importantly, it is one thing having a high performance platform, it is another having an aircraft that "runs away" from the cadet. The CT-4E's performance and handling qualities are tempered so as not to get too far ahead of the *ab initio* cadet pilot.

A syllabus for *ab initio* military flight training course could typically cover approximately 50 hours in two phase. Phase 1 is usually a two-

TANDEM OR SIDE BY SIDE?

THE TWO seat configurations for trainer aircraft are either pilot and instructor side-by-side or in tandem, usually with the pilot in front and the instructor behind.

The side-by-side seating configuration has the advantage that pilot and instructor can see each other's actions, allowing the pilot to learn from the instructor and the instructor to correct the student pilot.

It is now the norm for pilots to begin their flight training in an aircraft with side-by-side seating and to progress to aircraft with tandem seating. This, however, has not always been the case.

For example, it was usual to find tandem seating in basic trainers such as the biplane Tiger Moth and the Harvard of earlier generations which very successfully produced many thousands of great pilots.

Even on fast jets, side-by-side seating was successfully used in the operational conversion of fast jets such as the Vampire and later the Lightning. ✈

week, 15-hour syllabus oriented towards identifying applicants with a natural aptitude for flying and personality suitable for officer training and addressing aircraft handling, circuits, elementary aerobatics, forced landings and an introduction to three-dimensional flying such as unusual attitudes.

After 25 hours the cadet would submit to a general flying (GF) progress test where his/her progress would be assessed.

Phase 2 would typically continue with initial IF and night VFR training, dual and then solo navigation with further GF training including more advanced aerobatics such as the roll off the top, figure 8 and barrel roll.

By the end of the flight screening process, the air force must have a very good idea of how well the applicant will handle flight training, while also gaining a good insight into the applicant's ability to function in a team environment. Those applicants who pass the flight screening will have had the benefit of knowing to some degree what awaits them in the basic flight training phase, in turn bolstering their confidence and reducing washouts due to confidence problems in the next phase of training.

FLIGHT TEST OF THE CT-4E

World Airnews was given the opportunity of testing this aircraft soon after its arrival in South Africa. It started with an assessment of the takeoff performance from Wonderboom's 4 100-foot elevation runway 06 on a 20°C day (density altitude = 5 170 ft) with 26,2"/2 690 rpm, rotation at 60 KIAS and liftoff at 65 KIAS. Ground roll was estimated at approximately 360 metres with 420 metres to clear a 17 m obstacle.

Pilots need a good basic foundation on elementary flight instruments before considering "glass cockpits" and the associated automation addiction effects possible.

A snapshot of excess power available was assessed by means of a climb through 2 500 ft from 5 000 ft to 7 500 ft. In average ISA+13°C conditions, time required to climb through 2 500 ft was 2,5 minutes which was equivalent to an average rate of climb of approximately 1 000 ft/min, a rate which would not overwhelm the cadet pilot with no previous flying experience.

Accelerating the aircraft from 80 KIAS to the maximum level flight airspeed, 135 KIAS, (152 KTAS) at 85%/7 500 ft pressure altitude (ISA +13°C) required 27 seconds, equating to approximately two knots per second.

The combination of relatively short take off distance, relatively quick rate of climb and good acceleration, would provide adequate performance for the manoeuvres and profiles included in the *ab initio* role without running too far ahead of the cadet pilot.

Next, the level cruise performance assessment was essential to determine the ability of the aircraft to provide an efficient platform for navigation and as such, specific air range is a critical parameter.

An example of cruise performance was conducted at 7 500 ft pressure altitude and at a mid-weight of 894 kg; the range of the CT-4E at 65%/150KTAS would provide an economy of at least 9 nm/gal which would enable a range of approximately 400 nm with no reserves which was considered acceptable for the basic navigation exercises included in the *ab initio* syllabus.

STABILITY AND CONTROL

The ground handling characteristics offered by the relatively wide, three-metre wheel track, provided for easy directional control. In fact, cadet pilots with no previous flying experience, would have no problem in taxiing or controlling the aircraft on the ground during takeoff or landing.

The stall characteristics were evaluated at a weight of 945 kg, approximately 236 kg below MAUW. Stall warning typically occurred at eight to 10 knots higher than the stall speed with mild buffet onset followed by a generally uneventful stall; with a slight right wing drop in the approach configuration being exhibited, but was easily controllable by the use of rudder.

Stall speeds in all three configurations tested were cruise configuration at 65 KIAS, approach flap at 57 KIAS and 50 KIAS in landing configuration. The average height required for recovery, was typically 250 feet.

The flying qualities of the CT-4 were evaluated in the cruise configuration at 7 500 ft pressure altitude, 23"/2450 rpm and 125 KIAS. Longitudinal stability, both static and dynamic, was evaluated by assessing the Phugoid motion and the short period pitching oscillation damping.

In both cases, as would be expected from this class of aircraft, the Phugoid period of 35 seconds was positively damped with half amplitude within two cycles while short period damping was nearly aperiodic, that is approaching "deadbeat".

The implications of this in terms of handling and flying qualities was that the aircraft under those conditions, would be easily controllable in pitch due to predictable response to pilot or

atmospheric turbulence input.

Lateral directional stability was assessed through the traditional flight test techniques of steady heading sideslips, spiral stability, bank-to-bank rolls and Dutch roll damping. In all cases, positive static lateral directional stability was exhibited; control forces and displacements were in the in the correct sense while Dutch roll damping, was positive.

Adverse aileron yaw and yaw due to power and speed effects, was easily controllable through the combined use of rudder and aileron.

To assess the agility and robustness of this fully aerobatic (+6G to -3G) aircraft, aerobatics included loops, rolls, wingovers and barrel rolls, all commenced from approximately 160 KIAS. The enhancing feature of the flying qualities during manoeuvring was the smooth stick force/g-gradient and the predictability about all axes which facilitated the "pointing" of the aircraft while the adverse aileron yaw was easily controllable by the intuitive use of rudder to balance manoeuvres.

The aerobatic manoeuvres were entered from a wingover and shallow dive with the loop entry at 3,5g/160 KIAS, apexing at 70 KIAS/1 500 ft above start height. Control of the recovery pullout was enhanced by the all round visibility the "360 bubble canopy" single piece windshield provided, which facilitated wide visual cue acquisition for spatial awareness and attitude control.

From a teaching perspective, the all round visibility during manoeuvres would negate the requirement for the cadet pilot to have "head in the cockpit" trying to interpret aircraft attitude from the artificial horizon.

With the relatively short wingspan of 7,93 metres, roll rates approaching 240°/sec were achieved at 140 KIAS. In the final analysis, the combination of stability and control characteristics and performance, the "solid feel" of the well harmonised controls about all three axes, adequately represented typical characteristics of a modern military aircraft which would be suitable for the *ab initio* training of military and even civilian pilots.

The CT-4E, as could be expected from the conventional design, exhibited positive speed stability in the landing configuration at 85 KIAS (V_{ref} +10 kts)/50 ft obstacle simulation over the threshold and landing on runway 29, the aircraft was turned off the runway in about 490 metres, without excessive braking.

BASIC SPECIFICATIONS:

Pacific Aerospace CT-4E Air Trainer

Weights & dimensions:

Basic empty weight: ....807 kg
Maximum takeoff weight: ....1 180 kg
Fuel capicity: ....199 litres
Wingspan: ....7,9 m
Wing area:..................................39,32 m^2
Wing loading:........................20,2 lb/sq ft
Length: ....7,16 m

Performance:

V_a manoeuvring: ....144 kt
V_c cruising speed:...........................150 kt
V_s stalling speed:..............................45 kt
Takeoff distance: ....183 m
Rate of climb: ....1 830 ft/min
Landing distance: ....168 m
Service ceiling: ....18 000 ft

CONCLUSIONS

I have often wondered why the Royal Australian Air Force, the Royal New Zealand Air Force, the Thai Air Force and New Zealand's national aerobatic team, the Red Checkers, use the CT-4.

Now, having conducted a qualitative evaluation, the question was answered – a power loading of 8,7 lbs/hp coupled to an agile, yet robust airframe, provides an ideal aerial teaching and learning platform for aspirant military pilots, and yes, even formation aerobatics. And, of course, it is ideal, too, for civilian pilot training.

The fact is that suspension rates of cadet pilots worldwide differ and vary from as much as 50% to as low as 5%. Not surprisingly, though, it has been found that air forces with the highest pre-filtering mechanisms, have the lowest suspension rates.

The CT-4 has trained many of the top military pilots in the Pacific Region over the past decades and considering the demonstrated performance and handling qualities, there is no doubt that the CT-4E is at the forefront of high-performance trainer aircraft while retaining its legacy as a robust aircraft.

The light, well balanced and predictable handling characteristics make the CT-4E an ideal platform for basic military training providing an effective low cost, lead-in trainer to the more powerful turbo-prop trainers usually encountered in basic flight training. ✈