

UPDATING MIRAGE TACTICS 1975

Barry Schulz, AFC



Barry was born 9 December 1944 in Berri, SA.

Barry joined the RAAF Air Training Corps on 16 April 1957, He was awarded a Flying Scholarship with the RAAF on 21 October 1960, achieved his first solo flight on 2 April 1961 and was awarded top ATC Flying Scholarship Student 1961. He was discharged from the ATC on 9 December 1962.

Barry joined the RAAF on 24 January 1963 and, following completion of pilot training, was commissioned on 13 August 1965. After post-graduate training on SABRE and MIRAGE fighter aircraft, he then completed operational tours in No 76 and No 3 Squadrons - RAAF Williamtown, NSW. Following graduation from the RAAF Mirage Fighter Combat Instructor's Course in 1968, he completed MIRAGE operational tours at No 3 Squadron - RAAF Williamtown, NSW, and Air Base Butterworth, Malaysia - 1969 to 1970, No 2 Operational Conversion Unit - RAAF Williamtown, NSW - 1970 and, 1975 to 1977, and No 75 Squadron (Air Base Butterworth, Malaysia - 1980 to 1981.

Barry served on USAF Exchange Duties flying O-2A aircraft as an USAF Forward Air Controller and Fighter Combat Instructor in the Republic of South Vietnam - January to September 1970 and as a Fighter Combat Instructor on F-4E fighter aircraft at the USAF Fighter Weapons School, Nellis AFB, Nevada - 1972 to 1975. From 1977 to 1979 he served as a Staff Officer in the Directorate of Personnel Officers - Air Force Office, Canberra. Barry attended the RAAF Advanced Staff Course in 1982, joining the Directing Staff at RAAF College - RAAF Fairbairn, ACT from 1983 to 1984.

In July 1984, Barry was appointed Staff Officer-Training at Headquarters Integrated Air Defence System - Air Base Butterworth, Malaysia, including, flying CARIBOU transport aircraft, and in July 1986, held the Operational Requirements - Fighter post in Air Force Office, Canberra. Following F/A-18 fighter conversion in June 1988, Barry held the Staff Officer-Plans and Development post at Headquarters Tactical Fighter Group - RAAF Williamtown, NSW. In January 1990, he was appointed Staff Officer - Operational Evaluation and, in January 1992, Staff Officer - Plans and Policy at Air Headquarters Australia - RAAF Glenbrook, NSW. Barry held the position of Tactical Fighter Project Manager and Tactical Fighter Project - Coordination and Definition in Material Division - Air Force, Air Force Headquarters - Canberra, ACT from January 1994 to July 1995.

From July 1995 to December 1998 Barry was a Senior Military Staff Officer in the Defence Science and Technology Organisation (Directorate of Trials) – initially in the Staff Officer-Trials post and, in November 1997, he was appointed as the Deputy Director Trials-Air Force.



In the period 1995-1997, he managed the establishment of a Ballistic Missile Range at Anna Plains Station, 80 Mile Beach, WA for Project 'Down-UNDER Experiment' (DUNDEE). Four missiles were launched as representative ballistic targets for HF Radar trials.

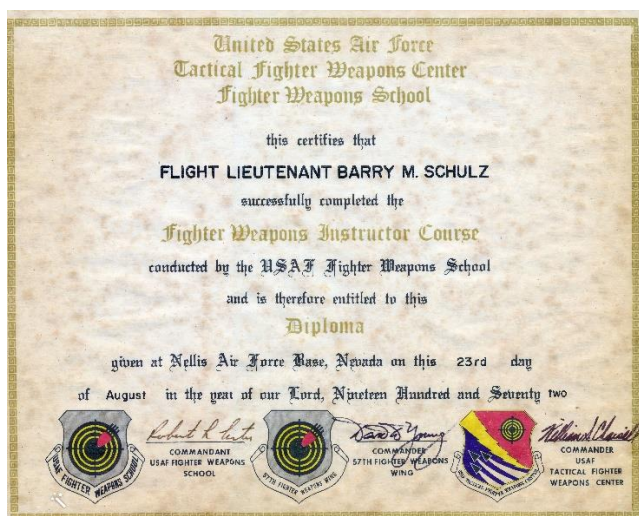
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BACKGROUND

I was an USAF Exchange Officer at the 414 Fighter Weapons School (FWS), Nellis AFB, Nevada from January 1972 until Dec 1974.



Note the TISEO mount



There was also a RAF and RCAF exchange officer at the FWS. Collectively we were 10% of the instructor population; this rose to about 30% whenever USAF instructors deployed on 'roadshows' to update US, European and SEA squadrons on tactics and intelligence matters.

The FWS has a long history of being the centre of fighter combat expertise since post WW2.

The USN 'TOPGUN' School is acknowledged as a like unit.

The RAAF's FCI course conducted by 20CU rates as an equivalent centre of expertise.

The main role of the FWS is to train exceptional USAF pilots and Weapons System Officers to become Fighter Weapons Instructors and tactics development officers at their home unit. The course was about 5 months duration and consisted of Air Combat Tactics, Ground Attack Range, Ground Attack Tactical, and Nuclear Weapons Phases with extensive academic and flying elements.

The FWS was also responsible for tactical development and weapons employment procedures across all USAF fighter employment disciplines.

Every FWS instructor was qualified as an instructor in all roles:

The FWS was regularly subjected to 'no notice' TAC Evaluation Assessments which included aircraft maintenance capability. All instructors were tested. Typically, an intercept was flown followed by ACM engagement. Gun camera and Radar film were assessed. We always carried a spare recorded radar film cassette in our G-suit, just in case the radar was not performing to specifications on the day.

The FWS was equipped with the upgraded F-4ES modified with leading edge slats (an improvement in aircraft handling) and Target Identification System Electro-Optical (TISEO).

Reputed to be departure-proof it was found that, if one tried, it would depart spectacularly. Returning to Base with a length drag-chute strap streaming behind the aircraft (deployment of the drag chute was the departure recovery procedure) was a tell-tale to be avoided.



TISEO was a long-range camera installed in the left-wing leading edge. It was capable of tracking targets or slaved to the radar antenna. The radar displays were upgraded to digital displays.

TISEO was used to enhance ground and air target identification; eg, up to 15-20 nm on an F-4 sized target. This met Rules of Engagement requirements.

Before commencing the tactical training phases, students were re-taught how to fly the F-4ES to the aircraft and their limits.

USAF Units were often restricted from low-level flight below 10,000 feet, no supersonic tactics, and a restricted envelope in which to fly the aircraft; G and Angle-of Attack (AoA).

This training included high energy manoeuvring, high AoA manoeuvring and optimum turning velocities; aka, 'corner velocity'.

Energy–manoeuvrability theory is a model of aircraft performance. It was developed by Col. John Boyd, a fighter pilot, and Thomas P. Christie, a mathematician with the United States Air Force, and is useful in describing an aircraft's performance as the total of kinetic and potential energies or aircraft specific energy. It relates the thrust, weight, aerodynamic drag, wing area, and other flight characteristics of an aircraft into a quantitative model. This allows combat capabilities of various aircraft or prospective design trade-offs to be predicted and compared.

'Unloaded accelerations' and 'corner velocity' were practical applications of the theory.



Low level navigation skills were also honed; this led to some interesting incidents with aircraft returning with branches and leaf matter in tanks!

Students were given high-G exposure at the Brooks AFB, TX centrifuge.



I was appointed 'FWS Cine Officer' responsible for managing the gun camera assessment facility.

Gun camera and Radar film was extensively used as a debriefing tool.

The appointment also entailed 'Silver Recovery Officer' duties (don't ask!). I overcame this onerous duty by acquiring colour film!

Weekend 'Cross country' flights were always encouraged; my more memorable flights being:

- **RCAF Cold Lake, Canada.**

- *The first in 1973, saw our 4-ship F-4ES denied crossing the border from Malmstrom AFB, Montana. Ever cooperative, the RCAF flew down and picked us up in a mix of F-104G and T-33 aircraft.*



Later that night, the TAC Command Post ordered us to RTB immediately - our beer-charged response was not appreciated!

When transported back to Malmstrom AFB (front seat F-104 - sweet aircraft), our F-4ESs were gone; they were already in Israel on Alert 3 within hours of arrival!

We were rescued by a fleet of USAF T-39 aircraft.

- *The second in 1974, I had Dr Graham Moller (Nellis AFB F-111 Flight Surgeon) in the back seat. We went from a 40 deg C high desert to a -20 deg C snowstorm which took two GCAs to find the runway. During engine start two days later, hydraulic fluid from cold damaged seals covered the tarmac (wondered why all the F-104s were hanged!). We were rescued a week later. Got to fly a few F-104 range sorties.*
- **Andrews AFB, Washington DC.** *The RAF exchange pilot and I flew to Andrews, AFB for a duty 'refreshments' pick-up from the Embassy suppliers. We managed to squeeze 13 dozen of the best wines into the ex-napalm tank Travel Pods ... bug eyed troops when we unloaded the booty!*

NOFORN intelligence criteria potentially restricted exchange instructor performing our duties in all FWS roles. However, at squadron level, we were privy to all the necessary information to be effective instructors. We were excluded from highly classified briefings, although, we were later briefed on them or, were able to listen to most briefings by means of access 'back stage' from my office! It was an unfortunate situation but fortunately, the squadron chose to turn a blind eye!



In 1974 I attended the USN 'TOPGUN' School as an academic student and flying in the backseat of T-38, F-5, and A-4 dissimilar aircraft with an instructor.

An elected Labor government saw the demise of this most valuable exchange position at the end of 1974. The post was re-established elsewhere flying A-7, F-15 aircraft.

USAF TACTICS DEVELOPMENT - 1972 - 1974

Air Combat Tactics

RAAF and USAF Air Combat Tactics were pretty much on par in the early 1970s.

The continuum in ACT from the Korean War theory and practice were inherited and applied up to this period.

Basic air combat manoeuvres had not really changed since WW1. Fighter performance, manoeuvrability and equipment have modified many classic manoeuvres, but a yo-yo is yo-yo etc. The emphasis on 'dog-fighting' was almost negated by the missile. However, the skill of close combat has reemerged with highly capable missiles and cannon.

The USAF soon recognised that their successes in Vietnam were far exceeded by the USN; kill ratios of 12:1 versus 5:1 were telling!

USAF Headquarters directed that the Tactical Air Command correct this anomaly. The FWS was, in turn, tasked with implementing change.

USN air tactics were studied at length and many of the USN tactics were adopted albeit, with a different title; eg, '*Combat Pair*' versus '*Loose Deuce*' etc. Combat Air Patrol (CAP) tactics became the solution to protecting the strike aircraft thus enhancing their success and survival.

Further, the threat from enemy Radar, SAM and AAA had to be addressed.

A decision to establish specialist Air Combat Squadrons in Vietnam operations, led to a new FWS role to train selected aircrew in newly developed air combat tactics techniques before they were assigned to that theatre.

'... *know your enemy*' become a catch phrase in the FWS and intelligence on Vietnamese (ie, Russian and Chinese) air combat and air defence techniques were studied at length.

The knowledge from '*CONSTANT PEG*' programme was showing positive results. Support from AWACS, '*WILD WEASEL*' jamming aircraft, '*COMBAT TREE*' (Autonomous IFF on board fighters), *TISEO* for longer range target ID to conform with Rules of Engagement, were all positive developments.

'CONSTANT PEG' was a natural outgrowth of the frustration many Vietnam-era pilots had with the structure of their training.

At the time, USAF tactics dictated a four-man, welded-wing formation for such fighters as the F-4. It was a configuration designed for combat with machine guns, with two aircraft serving as shooters, and two wingmen preventing adversaries from getting in close enough to attack the leaders.

In Vietnam, though, the enemy used missiles. A MiG could launch a tailshot from a mile back. In addition, the welded wing was unwieldy, taking as long as 30 seconds to turn 180 degrees.



As Vietnam veterans began to filter into the Air Force Fighter Weapons School and other training institutions, tactics began to change. The combat veterans established ways to turn the welded wing faster. They developed a two-aircraft fluid two formation.

Significantly, aggressor programs slowly took shape, with Weapons School instructors using Navy A-4s to simulate MiG-17s.

Note: *T-38, F-5E, F-102, F-106 and A-7 aircraft were also employed to provide dissimilar aircraft realism during training.*

In this context, the idea of using actual MiGs seemed a natural next step. "It was a logical progression, in my opinion," said now-retired Col. Gaillard R. Peck Jr. (ex FWS instructor), the first commander of the 4477th at Tonopah.



US intelligence technology exploitation programs such as 'HAVE DRILL-HAVE FERRY', and 'HAVE DOUGHNUT' began pulling MiGs apart to study their strengths and weaknesses as early as the 1960s. And so, one day in the mid-1970s, Peck found himself briefing Maj. Gen. Charles L. Donnelly Jr., Air Force deputy director of plans and policy, on the idea of a training program featuring actual MiGs.

Donnelly thought it sounded good. He said he'd provide the airplanes if Peck, then a tactics officer based at the Pentagon, could produce an airfield (Groom Lake, NEV was the obvious choice). Peck asked Donnelly if he had a call sign. It was "Constant." Wandering back to his Pentagon office, Peck thought of his wife, Peg. He recalls thinking, "CONSTANT PEG" had a nice ring to it, "and that's what it became."

Vietnamese air defence developments needed to be countered. Their detection capabilities and tactics had been developed and were becoming very successful. Radar detection using intermittent radar site transmissions (to negate the Anti-radiation missile threat) and triangulation from radar sites were perfected. SAM radar use of paired radar units tracking (one in elevation the other in range) and with optical tracking fallback were challenges. USAF EW and CHAFF

were timely developments for all platforms. SAM evasion manoeuvres became a skilled and successful technique

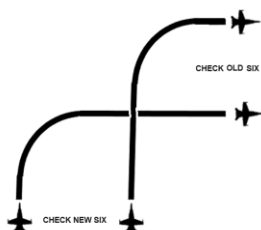
Tactical formation sizes, layout and manoeuvring were dramatically revised. Tactical formations were tending towards more fluid two combat pair four-ships. Spacing was adjusted to enable better use of all eyes, a more fluid formation dynamic was accepted and enabled more efficient lookout by all formation members. These all provided a degree of 'self-protection' to the formation.

Visual Search Technique. *The physiology of the human eye was considered and the following emphasised:*

- **Detection.** *An object must subtend about 1 minute of arc for the eye to be able to register the object in ideal conditions (this equates to about 10 m at 12.5 nm). To register an object, the eye must have a finite time for the light reflected by the object against the background to register on the retina and for the brain to analyse the image. If the eye is moved from the object, the image is no longer being registered and the object is lost. Further, unless stimulated by focussing on a distance object, the eye 'idles' at a focal distance of about one metre; therefore, the eye must be re-focussed on a distance object (eg, cloud) for it to be able to register a distance object on the retina.*
- **Peripheral Vision.** *If an object is moving with respect to its surroundings, it may be registered by the peripheral vision properties of the eye. This will automatically draw the eye to the object.*
- **Visual Search Patterns.** *A disciplined pattern should be adopted to ensure that a search sector is thoroughly covered in the most efficient way. A steady slow to medium-paced sweep action sweep fore-aft along altitude bands or, an in-out sweep in sectors of about 10-15 degrees should be used.*

Formation turns were developed to complete the turn as soon as possible to prevent predictability and the breakdown of lookout. Delayed, In-Place, and Cross Turns were introduced using 4-5G. Weaves added to the unpredictability of formation navigation and variation in aircraft heights and spacing challenged ground Radar and SAM / AAA operators. Closing and opening aircraft horizontal and vertical separation caused loss of radar discrimination at the 'merge' and denied tracking and firing solutions.

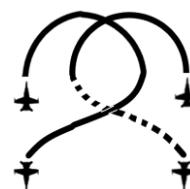
DELAYED TURN
CAN BE ADJUSTED FOR ANY
DIRECTIONAL CHANGE;
eg, 45 / 60 deg



IN-PLACE
90, 180 deg



CROSS TURN & WEAVE



4-5G turns were made without radio calls by lead using SOP wing rocks, wing flashes and porpoises to signal intent.

Conducting ACM required new techniques and communications. Callsign discipline relaxed (formation callsigns reverted to personal callsigns in the heat of battle) and, highly descriptive 'verbal diarrhoea' of what one was doing and thought, being replaced with crisp short SOP phraseology:

- **Engaged** - *'I'm committed to my attack; you are to support me'*
- **In / Off** - *'I'm about to commit / I'm repositioning'*
- **Slice Back Left / Right** - *'Turn back into fight nose low - the fight is low L/R'*
- **Pitch Back Left / Right** - *'Turn back into fight nose high - the fight is high L/R'*
- **Come Back Left / Right** - *'Turn back into fight nose level - the fight is L/R'*
- **Clear** - *'I see you, you have no threats - I'm (clock code) - high / low'*
- **Extend (Heading)** - *'regain energy, standby to PITCH BACK L/R / DISENGAGE'*

Tactical air combat using missile and guns. The 'CONSTANT PEG' programme at Groom Lake involved FWS instructors piloting and flying against various MIG types developing tactics against that threat.

In 1973 the FWS exchanged tactical knowledge with the attendance of two Israeli pilots - Major Asher Snir (12.5 kills) and Captain Eitan Ben Eliyahu (5 kills+?) - both became IDF Air Force chiefs.

Aircraft fatigue was always a concern to me as the F-4E had no fatigue monitoring system.



Pilot reporting was not reliable; eg, I physically pushed against an experienced FWS instructor as he pulled into a sustained 10G turn; during RTB he asked me to reset the G-meter and he applied 6G! He was pissed when I wrote the aircraft up as 'overstressed' - the only proof being my back-seat G-meter recording 10G!

CAPT Snir, IDF had an interesting landing because of failure of his aircraft's horizontal stabilizers in flight!

One aircraft was lost due a wing outer section folding and cutting the aircraft in two. Subsequently, wing fold mechanisms were inspected and eventually modified. For a period, pre-flight of the wing-fold mechanism was made using 'feeler-gauges' to check tolerances if up / down movement was suspicious.

Operations against dissimilar aircraft. Dissimilar tactics against T-38, F-5, A-4, F-102, F-106, A-7, F-104, and F-8 were introduced. Later an Aggressor Squadron was formed and specialised in enemy air tactics.

I managed to fly in all these aircraft during FWS sorties.

Air-to-Air gunnery. The TDU-10 "Dart" towed target was used; Straight, Circular and Combat tows (1v1 and 2v1) patterns were developed. The dart was air-scored by flying in formation and it was dropped at a designation range area.



1V1 Combat Tow. *I achieved a 25 second kill against the Dart. Other attempts were not quite as successful due to lack of radar lock.*

The preferred technique was a hard turn towards the Dart with an immediate roll under inside the Dart's turn to yo-yo into a 'lead-pursuit' 6-7G approach at 'corner velocity' for a firing solution. A proficient back-seater would achieve a lock-on or, the pilot would need to use 'bore-site' mode (a disadvantage was the need to go into 'pursuit' until lock-on and then lead-pursuit).



Once a tracking solution was achieved, open fire at 2000 feet with the good 'ole M-61 20 mm.

Many pilots resorted to the 'spray and pray' technique or, the 'fly through' shot.

The latter was taught as a valid technique, as any opportunity should not be wasted. If a tracking solution was not achievable, take a 'fly through shot' and disengage!

The important factors being line, range, and lead ... and of course avoid the collision!

At the FWS we even practiced un-authorized Dart versus Dart sorties!

Conventional Weapons Delivery

Conventional bombing (using manual and dive-toss system deliveries), rocketry and gunnery were practiced day and night on a scored range.

HE weapons (low and high drag) tactical strikes (using manual and level / dive-toss system deliveries), were practiced day and night (self-delivered flares) against marked targets and simulated runways, vehicle convoys and infrastructure. Visual and radar navigation was used. Dissimilar aircraft and SAM / AAA enemy air was always a threat.

Tactical reconnaissance using fast FAC procedures were honed.

Slow FAC using low level target marking from a distance was explored.

Conventional Weapons

- **Training Weapons.** BDU-33, 2.75" rockets and 20 mm cannon were used for basic day and night training.
- **Tactical Weapons.** HE SMART (Laser and Electro-Optical guided) and HE BALLISTIC (high and low drag) bombs were used.



I flew the prototype YA-7E for an evaluation tasked by RAAF Washington - three front-seat sorties included navigation and multiple bombing runs.

The next generation weapons delivery capability was impressive.

- **Air-to-Ground missiles**
- **Rocketry**
- **Anti-Radiation missiles**

Nuclear weapons delivery



Nuclear weapons profiles using B-61 (750 lb) (pictured), and B-57 (500 lb) 'shapes' (nuclear weapons inert bodies).

Computer controlled deliveries included level retarded, toss and loft deliveries.

The most enjoyable profile was the 'loft' where a 'shape' was released in a 45 deg climb followed by an escape manoeuvre. After release, we would often roll towards the 'shape' (it would be only 50 feet separation), and follow its trajectory in formation for as long as possible.

Operations in a hostile EW and SAM environment. Against Ground Radar, SAM, and AAA.

Using Radar Homing and Warning (RHAW) equipment and an AGM-45 Shrike missile radar emitters could be identified and engaged. However, if the SAM / AAA radars were used intermittently and / or in concert, they could lure the fighter into the 'Valley of Death' with no escape.

An Electronic Warfare Range was established in the Caliente Valley north of Nellis AFB. This range was active during all training periods so pilots were always familiar with threat signals and tactical requirements. Soviet SAM and AAA radar signals were generated and SAM launch simulators gave visual reality to the scenario.

Use of chaff and flares. These were simulated during all sorties.

Air Refuelling. This was integrated into instructor currency requirements combining with ACT missions.

Regular Weapons Fire Power Demonstrations. These demonstrations to international military observers featured an F-4ES dogfight against Aggressor aircraft culminating in a live Sidewinder launch at a flare started the show. An F-111 low-level supersonic delivery, F-4ES multiple strikes and FAC-controlled close air support was demonstrated using missiles, Smart and Ballistic bombs. Competition was intense to get high value weapons to deliver.

All the above elements were consolidated into the Ground Attack Tactics Phase in which strike force packages included dissimilar air, active SAM, AAA and EW radar and electronic signals threats - these were the precursor to the '*RED FLAG*' exercises.

RAAF MIRAGE INTRODUCTION TO NEW TACTICS - 1975 to 1977

Air Combat Tactics

On completion of my exchange tenure in January 1975, I was posted to 2OCU. I was eager to introduce my knowledge into RAAF Mirage and Introductory Fighter Course training. However, my initial attempts to introduce USAF tactics were met with considerable resistance by the 'old and bold'!

I brought home many Tactics Manuals relating to air and ground tactics and information on threat aircraft etc.

Therefore, I began a 'softly-softly' stealthy approach of introductory lectures on the air war in Vietnam, the findings of '*CONSTANT PEG*' programme, and the FWS development of new tactics which were proving successful in Vietnam.

I teamed-up with a few FCIs and introduced them to the 'new look' fighter tactics. Soon I had convinced 2OCU staff of the way ahead and acceptance was eventually achieved.

WLM OC Flying, GPCAPT Tex Watson, was shocked as he left his office, seeing a formation pitching out with an apparent near mid-air between the lead and his wingman (he had witnessed his first Delayed Turn pitch out from a close tactical formation). After fending off a 'WTF' phone call, I invited him to attend a briefing on our new tactics and to fly an introductory sortie. Fortunately, he was convinced that we were not 'cowboys' and he subsequently endorsed our developments.

I was keen to introduce these tactics into the upcoming FCI courses.

Hence, I rewrote the Air Combat Manual. 2CRU controllers were attached to the FCI course to develop their skills into the air combat environment as 'wingmen' or tactical controllers rather than intercept controllers.

I participated in a trial of the USAF Dart system engineered for a Mirage carriage. This was a great advance on the 'banner'. Unfortunately, the tow cable, despite having Kevlar heat shield protection, was compromised by jet exhaust especially when turning using afterburner. Dave Robson was the test pilot.

The USAF Dart system was superior in that it could be manoeuvred at high speed and normal G limits.

In effect, a more realistic target was facilitated; versus the slow and essentially non-maneuvrable 'banner'.

Missile firing against Jindivik and flares dropped from Caribou were successes.

Live Air-to-Air firing against the 'banner' were expanded to include:

- **Circular tow**
 - **Conventional.** The four-ship pattern.
 - **'Tactical' circular tow.** Using two-ship and four-ship tactical manoeuvring.
 - **'Tactical' combat tow.** Using two-ship tactical manoeuvring but, allowing the Canberra tug to reverse the tow direction if the pattern discipline broke down. Clearly this was closely controlled by the flight lead and the Canberra Range Safety Officer. Later, the more experienced Canberra crew were permitted to initiate the reversal.
- **1v1 Banner**
 - The 'fight' was set up from a head-on pass and, at the merge, the tow initiated a turn into the attacker
 - The attacker then was free to manoeuvre. The exercise was timed. This exercise promoted skilled use of energy management, use of the vertical and fine judgement to maintain a safe 'angle off' at the firing point.

The opportunity to conduct air combat tactics against deployed USAF F-4 from Clark AFB and, against F-14 off the USN 'Enterprise', were invaluable in re-enforcing the 'new' tactical concepts.

Ground Attack Tactics

I also rewrote the Ground Attack Manual for the FCI Course.

This was not such a challenge as I was the Phase manager and lecturer for the Conventional Weapon Delivery Phase of the FWS course; thus, it was a simple translation of my USAF Manual (my FWS mentor was CAPT Dwane Madden - ex-2OCU exchange officer!).

The use of the ^ on the gunsight to set-up the initial gunsight picture at rollout in the dive, the rule of thumb for the release sight picture of 2 mils per K of crosswind and 1 to 1.5 mils per knot (dependant on dive angle) for head / tailwind allowance were fundamental concepts.

The fact that ballistic weapons were not affected by wind but, only by movement of the airmass the aircraft was in at release was hard to promote.

The use of doppler to sample the airmass enabled more accurate initial weapons release.

A range of tactical strike profiles, tactical reconnaissance, and weapons delivery profiles were explored.

I also introduced night bombing including, under flares released by Caribou aircraft.

General

Multiple 2OCU staff visits to Williamtown and Butterworth squadrons introduced these tactic developments and flying practice demonstrated the 'new way'.

For the more academically inclined, I introduced a new bombing technique guaranteed to improve their bombing results. After a long introduction considering the factors influencing the bomb's trajectory, Coriolis, aircraft velocity and gunsight technique in the dive, a series of shaky algebraic formulas derived a solution to the bombing equation; viz: bombing accuracy = T+L+A+R (That-Looks-About-Right at release)!

The looks on their faces as they realized the significance of the technique was precious!

My one concern about the changes in tactics was the impact of a higher accumulation of the dreaded 'microfails' (due to the increased use of higher G turns as SOP), higher energy manoeuvring and, the emphasis on the use of rudder during high AoA manoeuvring - the Mirage was an interceptor; go fast go straight design! This became a manageable factor within the Mirage fleet.

NO 75 SQUADRON TACTICAL TRAINING: 1980 - 1981

I had the privilege of holding the Executive Officer post under COs Dave Bowden and Brian Weston in this period.

The further development of training methods was enabled during their tenure:

- **Air Combat Tactics**
 - **Reinforcement of the 'new' tactical concepts.** Tactical formations, tactical turns, 'combat pairs', energy management, optimum turn performance
 - **Use of live Air-to-Air Circular tow and Combat tow**
 - **Live firings of MATRA / R550**
 - **Up-skilling of Malaysian Air Defence Controllers.**

Malaysian controllers at Butterworth were introduced to the 'combat controller / wingman' concept. After some doubts in their ability and the capability of their equipment, they rapidly became skilled operators and contributed to the effectiveness of the Air Defence Radar unit and support of the air tactics of the Mirage squadrons.

The use of a 'bullseye' (Pulau Perak Island in middle of Malacca Straits; aka BSR - 'bird shit rock') exercised 'broadcast control' skills to engage another formation.

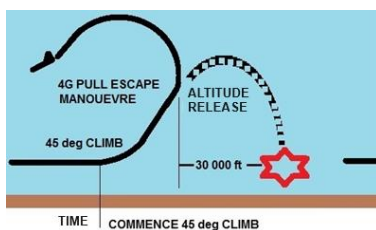
- **Ground Attack Tactics**

- **Curvilinear Weapons Delivery.** Using a curvilinear approach from the 'base position' and rolling wings level just before weapons release, the tracking ability of ground weapons was complicated. The approach was practiced with strafe and bombing attacks. More of a low threat environment tactic, it improved the skills of the pilots to judge release point management. Two aircraft multi-profile strafe and bombing patterns with variable attack headings (except strafe!) were practiced at Song Song Range.



Cooperation with Malaysian AAA Air Defence units was used on an opportunity basis to practice these skills during navigation exercises and on Tengah redeployments.

- **Pop-up deliveries.** High and low angle pop-up approaches were used to hone aircraft handling skills and weapons release variables.
- **HE Toss.** Based on a nuclear weapons delivery profile HE Mk 82 bombs were 'lofted' onto WSD-42 on the SE coast of Malaysia. The deliver enabled weapons delivery under low cloud conditions.



The attack commenced from an IP, progressed at a fixed speed and altitude; at a pre-calculated distance from the target / time, a precise 4G climb to 45 deg attitude was initiated and the bomb released at a pre-calculated altitude (fingers crossed!) Surprisingly, many less than 300 feet impacts were recorded. Of course, in the nuclear sense, the error did not really matter!

- **RPK-10 Programme**



The Squadron use of the RPK-10 bomb-tank carrier was introduced.

This presented a real challenge in take-off performance and range capability. Generally, it required a recovery to RSAF Tengah.

- **Night Bombing.** Night bombing was conducted on Song Song range after a suitable target lighting system was developed.

CONCLUSION

The RAAF was fortunate to be exposed to modern USAF and USN tactics development resulting from the Vietnam experience through the USAF exchange post based at FWS at Nellis AFB NEV.

The acceptance and consolidation of those developments:

- bought the RAAF fighter force up to date with the latest tactics in air superiority and ground attack environments
- enabled an easy transition into the F-18 aircraft.