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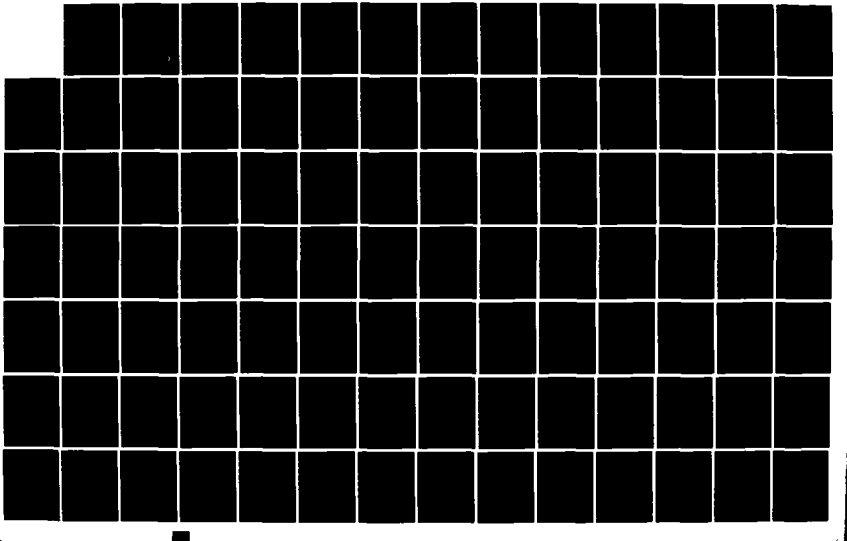

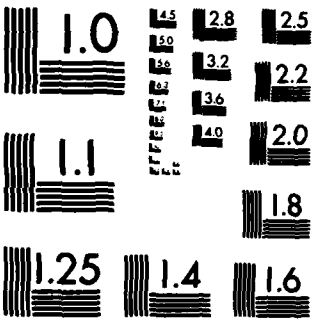

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CAN THE AGGRESSORS CONTINUE TO BE EFFECTIVE IN THE F-5E?

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

DONALD M. KREMPEL, MAJ, USAF
B.B.A., Kent State University, 1969

Fort Leavenworth, Kansas
1984

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20. ABSTRACT

The Aggressors were established with the mission to provide realistic, enemy oriented, dissimilar air combat tactics training for United States Air Force fighter units. They accomplished this mission since 1973 with first the Northrop T-38 and now the Northrop F-5E. The F-5E is an acceptable simulator of the Soviet built MIG-21 Fishbed which was originally produced in the early 1960's. This is 1984 and the Russian air combat threat has changed into a more sophisticated fighter force.

This study examined the capability of the F-5E to simulate modern Soviet air combat fighters, specifically, the MIG-23 Flogger, MIG-31 Foxhound, MIG-29 Fulcrum, and SU-27 Flanker. The investigation revealed that the F-5E is not an acceptable simulator for any of these aircraft. The upgraded F-5E with an improved radar, proved to be able to serve as a part-task simulator for only the MIG-23 Flogger. (author)

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ABSTRACT PAGE

CAN THE AGGRESSORS CONTINUE TO BE EFFECTIVE IN THE F-5E?
by Major Donald M. Krempel, USAF, 86 pages.

The Aggressors were established with the mission to provide realistic, enemy oriented, dissimilar air combat tactics training for United States Air Force fighter units. They accomplished this mission since 1973 with first the Northrop T-38 and now the Northrop F-5E. The F-5E is an acceptable simulator of the Soviet built MIG-21 Fishbed which was originally produced in the early 1960's. This is 1984 and the Russian air combat threat has changed into a more sophisticated fighter force.

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CHAPTER I

INTRODUCTION

"Train like you plan to fight." This statement has been uttered by virtually every fighter pilot at one time or another. However, when it comes to air-to-air combat training, this phrase is easier said than done.

For air-to-surface training, the fighter pilot can fly realistic missions on numerous tactical bombing ranges around the world. He can hone low altitude navigation and flying skills, fly actual combat weapons loaded aircraft configurations, practice terrain masking techniques, cross real ridgelines, drop live bombs on realistic targets, use onboard aircraft self-protection electronic countermeasures against realistic ground threat simulators, and even be shot at by harmless but realistic looking surface-to-air missiles (Smokey SAM's).

For air-to-air training, the solution is not as simple. Some training can take place in simulators. However, simulators are rare, expensive, and in their present state of the art are only good for exposing a pilot to the aircraft avionics, weapon systems, and basic air combat maneuvering skills. Flying air combat training missions in the actual aircraft against other aircraft, preferably dissimilar types

of aircraft, is the best way to train for air-to-air combat. This too has limitations. For example, the dissimilar aircraft may not resemble in size, performance, avionics, weapon systems, or even appearance an enemy aircraft; the pilots flying dissimilar aircraft are likely to fly friendly versus enemy tactics; real missiles and guns cannot be fired for obvious reasons; and rules of engagement restrict maneuvering and altitude arenas for safety purposes.

In 1972, the USAF started a program to train fighter pilots more realistically in air-to-air combat. A squadron at Nellis AFB, Nevada, was equipped with an aircraft that closely resembled the Soviet air threat encountered in Vietnam, specifically the relatively small-sized MIG-21. This squadron was named the "Aggressors," and the original Aggressor aircraft was the Northrop T-38. In 1975, the T-38 was replaced with the similar sized Northrop F-5E. Since then, the Aggressors have been flying the F-5E attempting to simulate the Soviet air threat and Soviet air combat tactics. This is 1984, and the Soviets have a new inventory of more sophisticated, larger aircraft.

PURPOSE OF THESIS

The purpose of this thesis is to analyze the current and future effectiveness of the F-5E's role in the Aggressor mission. This analysis will compare the F-5E with selected Soviet fighter aircraft to determine if the F-5E can continue as a realistic threat simulator for dissimilar air combat tactics training by the Aggressors.

BACKGROUND

"The story of air fighting began in 1914 when four R.F.C. (Royal Flying Corps) squadrons flew to France and scouted for the British Expeditionary Force."[1] Since this early exploitation of aircraft for military purposes, there has been a need for realistic air combat training. Since World War I the need for training has been relearned three times: World War II, Korea and Vietnam.

The results of Vietnam are our most recent and most disappointing examples. The United States Air Force kill/loss ratio of 2 to 1 during Vietnam was far below the 14 to 1 kill/loss ratio during the Korean War.[2] The extremely low Vietnam ratio is significant because the combat conditions for both Vietnam and Korea closely parallel: "the conflict was localized; political limitations were imposed on objectives; distances from the main supply base in the USA were very extended; and the quality of enemy pilots was relatively mediocre."[3]

This poor performance in Vietnam prompted the USAF to determine the cause of the problem and take corrective action. There had to be reasons why the USAF with apparently better trained fighter pilots, flying relatively more sophisticated aircraft, accumulated such a low kill/loss ratio over an enemy air threat assessed to be inferior.

The search consisted of an extensive seven-year study to analyze all Southeast Asia air-to-air engagements recorded by U.S. pilots. This study was called "Project Red Baron."

The findings of this study were numerous, but three stood out as relating directly to the training of aircrews prior to entering the war. The report revealed that aircrew knowledge of the threat itself was deficient; most MIG attacks were totally unobserved; and, once engaged, basic air combat pilot skills were lacking.[4] "The most common problem could be summed up in the words 'insufficient training and experience in air-to-air combat.'"[5]

Corrective action was initiated in October, 1972. The USAF Tactical Air Command (TAC) took a giant step forward in realistic air combat training when it established the 64th Fighter Weapons Squadron (FWS) at Nellis Air Force Base in Nevada. This squadron, known as the "Aggressors," was initially manned with experienced air-to-air pilots, equipped with the Northrop T-38 trainer aircraft, and trained to fly Soviet formations and tactics. The Aggressors were established to provide realistic, enemy-oriented, dissimilar air combat tactics (DACT) training for all reconnaissance units, training units, and operational tactical fighter units.[6] Three key words stand out in this mission statement: realistic, enemy and dissimilar. Prior to 1972, the USAF Tactical Air Command did not have fighter assets totally dedicated to fulfill these requirements.

The Aggressor program was an immediate success. The enormous demand for the Aggressors by TAC fighter units prompted TAC headquarters to establish a second squadron of

Aggressors at Nellis AFB in 1975. The Aggressors' popularity spread rapidly to other parts of the world as well. In 1976, Pacific Air Forces (PACAF) organized an Aggressor squadron at Clark Air Base in the Philippines to support the Pacific theater of operations. Also in 1976, the fourth and final Aggressor squadron was formed at Royal Air Force Alconbury, England, to augment training in the NATO theater.[7]

When the Aggressors were formed, they needed an aircraft that would closely resemble the current enemy fighter threat. The Soviet built MIG-21 was the primary enemy fighter threat in 1972. To credibly simulate this fighter, the Aggressor aircraft would need to possess as many MIG-21 characteristics as possible. The MIG-21's small size and smokeless engine made it extremely hard to see. It was capable of both slow speed fighting and supersonic accelerations. Its relatively low wing loading gave the MIG-21 a good turning capability. This MIG's weapon systems consisted of a short-range radar, a gun, and heat-seeking missiles.[8]

There was only one U.S. aircraft that could fill these requirements, the Northrop F-5E Tiger II. Unfortunately, due to the supply requirement for the F-5E in the country of South Vietnam, this aircraft was not available in 1972. The Northrop T-38 Talon trainer was temporarily substituted. Although the T-38 was similar to the F-5E in appearance, it lacked many of the F-5E's performance characteristics. Throughout 1975 and 1976 F-5E's became available and replaced the T-38's.[9] The Aggressors have been flying this aircraft ever since.

HYPOTHESIS STATEMENT

The tentative hypothesis of this thesis is that the F-5E, which resembles the characteristics and capabilities of the MIG-21, may possess unacceptable shortfalls when attempting to simulate modern Soviet fighter aircraft and tactics.

METHODOLOGY

Chapter II will provide a review of literature. This review will not be by document but rather by type of document. Types of documents will include: research studies, non-military publications, and military publications. The Soviet Union is virtually a closed society and maintains tight security control over release of military equipment specifications and capabilities. Since this thesis examines current and projected Soviet fighter aircraft characteristics, the credibilitiy of source documents will be assessed.

To determine shortfalls of the F-5E to simulate new Soviet fighters, the characteristics, capabilities, and air combat tasks of the F-5E and new Soviet fighters will be compared. First, the characteristics and capabilities of the new Soviet fighter aircraft must be determined before a comparison can be made with the F-5E. Chapter III will list the ten specific characterisitics and capabilities that will be used for the comparison. These include: size, thrust-to-weight ratio, speed, sustained turn rate, instantaneous turn rate, radar, missiles, gun, beyond-visual-range (BVR) capability,

and look-down/shoot-down capability. The Soviet fighters analyzed in this thesis are the MIG-23 (NATO Flogger), MIG-31 (NATO Foxhound), MIG-29 (NATO Fulcrum), and SU-27 (NATO Flanker).

Chapter IV will discuss and list the F-5E and MIG-21 characteristics and capabilities. Next the F-5E will be compared to the MIG-21, using the above ten characteristics and capabilities, to establish a standard for one aircraft to simulate another aircraft. The acceptability of this standard is based upon the fact that the F-5E has been accepted by fighter pilots for the past twelve years as a good MIG-21 simulator. This standard will be expressed as a percentage of difference. For example, the wing span of the F-5E is 27 feet; the wing span of the MIG-21 is 23 feet. This is a difference of 4 feet or 15 percent. Therefore, 15 percent difference is the "standard" for wing span.

Next, the F-5E will be compared against the new Soviet fighers to determine differences expressed in percentages. A matrix will depict the amount of deviation, if any, from the established standard. A deviation on the plus side of the standard of more than 10 percent will constitute a shortfall in simulating a particular characteristic or capability. In the above example where 15 percent is the standard for wing span, a range of 0 to 25 percent is acceptable, and no shortfall exists. The author used a 10 percent deviation figure for this study based upon a random concensus opinion of aggressor pilots and fighter pilots.[10]

Tactical Air Command has forecast the F-5E to be upgraded with a more capable radar and an all-aspect, short-range, heat-seeking missile capability in the 1986 timeframe.[11] Chapter IV will also compare the upgraded F-5E with the new Soviet fighters and depict the deviations from the standard as described above.

A mere comparison of characteristics and capabilities is not sufficient to determine if the F-5E is acceptable or unacceptable as the realistic threat simulator necessary for dissimilar air combat tactics training today. No single aircraft will be capable of simulating all of the different threat aircraft. Therefore, an analysis of characteristic air-to-air combat training tasks will be accomplished. The F-5E may be able to simulate some of the training tasks for each threat aircraft. In other words, the F-5E may be able to serve as a part-task threat simulator.

Chapter V will list and discuss the tasks that are characteristic of dissimilar air-to-air combat training. These inlcude: beyond-visual-range intercepts (look-up and look-down), visual attacks (offensive, defensive, and neutral), and weapons employment (radar, heat-seeking, and gun). An analysis of the F-5E capability to simulate each task for each new threat aircraft will be made based upon the variation matrix in Chapter IV. The same process will be accomplished for the upgraded F-5E.

Chapter VI will summarize the capabilities and limitations of the F-5E to provide realistic, dissimlar air combat tactics training for US fighter aircrews. It states conclusions to this study and makes recommendations for future study.

ASSUMPTIONS

1. Aggressor squadrons will continue to be organic to TAC, PACAF, and USAFE organizations.
2. Soviet built aircraft exploiting Soviet tactics will continue to be the primary enemy air-to-air threat for the USAF.
3. Soviets will maintain tactical aircraft numerical superiority over the USAF.

LIMITATIONS OF THE INVESTIGATION

This thesis is constrained in the following ways:

1. Much of the information about Soviet aircraft capabilities and tactics is classified. Therefore, Soviet characteristics and capabilities are dealt with only in general, unclassified terms so as to allow for widest dissemination of this study.
2. This thesis does not include an analysis of all enemy aircraft. It only examines Soviet/Warsaw Pact fighter planes that are considered to be the primary current and projected air combat threats to US fighter planes.[12]

3. Recommendations as to which aircraft should replace the F-5E, should replacement be desired, are not made in this thesis. This examination will only determine if the F-5E is still a suitable air combat threat simulator for Soviet fighter aircraft and tactics.

ENDNOTES

[1] Johnson, J. E. Full Circle. New York: Ballantine Books, Inc., 1964, p. 1.

[2] Momyer, W. W., General, USAF. "The Evolution of Fighter Tactics in SEA," Air Force Magazine, July 1973, p. 62.

[3] Grasset, P. "Dissimilar Air Combat Training--A Revolution in Realism," International Defense Review, 6/1975, p. 823.

[4] Berry,, F. C., Jr., "Think and Fly Like the Enemy," Air Force Magazine, April 1982, p. 38.

[5] Grasset, P. "Dissimilar Air Combat Training--A Revolution in Realism," International Defense Review, 6/1975, p. 825.

[6] RB 110-1, US Air Force Basic Data. Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, May 1983, pp. 4-7.

[7] Grasset, P. "Dissimilar Air Combat Training--A Revolution in Realism," International Defense Review, 6/1975, p. 825.

[8] Carson, D., Captain, USAF. "Teaching Tactics in TAC's MIGs," Air Force Magazine, March 1974, p. 45.

[9] Grasset, P. "Dissimilar Air Combat Training--A Revolution in Realism," International Defense Review, 6/1975, p. 825.

[10] Interviews and telephone conversations with Aggressor pilots and fighter pilots, February/March 1984.

[11] Devine, T., Major, USAF. Air Operations Staff Officer, OPR F-5E Aggressor Program, Langley AFB, Virginia, Telephone conversation, 14 January 1984.

[12] Harbison, P. Jr., Lt Col, USAF. Squadron Commander, 64 FWS, Nellis AFB, Nevada. Telephone conversation, 8 March 1984.

CHAPTER II

REVIEW OF RESEARCH LITERATURE

This chapter reviews the research material used in this thesis. The categories of research material include: research studies and non-military publications. The Aggressor program has only existed for twelve years. Therefore, most of the information about the specifics of this program has been printed in periodicals, not books. The focus of this thesis is the Aggressor aircraft, the F-5E. This thesis does not challenge the Aggressor concept itself. When attempting to compare aircraft characteristics and capabilities, especially Soviet types, much of the information is either classified or inaccessible. The fact that the MIG-29 and SU-27, two of the Soviet aircraft examined, are scheduled for initial operational service this year further restricts the quantity and quality of data available. However, enough pertinent information is available from a variety of respected aviation and defense oriented publications to satisfy the requirements of this thesis.

RESEARCH STUDY

Only two unclassified research studies relating to this thesis were of interest. Both of these study projects were conducted in 1979 at the Army Command and General Staff College. The first study project, titled "Will Aggressor

Squadrons Be Needed in the Future?" contained very useful and meaningful information. At the time that this thesis was written, the McDonnell Douglas F-4 Phantom was the predominant tactical fighter force for the USAF, and Aggressor F-5E's performed the primary dissimilar air combat role. Throughout the late 1970's, the USAF fighter inventory was being modernized with new generation fighters. These aircraft were the McDonnell Douglas F-15 Eagle and General Dynamics F-16 Falcon.

This thesis examined the need for the F-5E Aggressor squadrons to perform the dissimilar air combat role now that these new aircraft were available. The evaluation of Aggressor operations encompassed both training effectiveness and cost analyses. "The general conclusion of this thesis is that the F-5E Aggressor Squadrons should continue as the focal point of enemy tactics, weapon systems and philosophy."[1] The support for this conclusion is based mainly on economical reasons: initial lower costs, maintenance economy, and fuel economy of the F-5E versus the F-4, F-15, or F-16. Other support is based upon the F-5E's size and lack of engine smoke trail.

In 1979 the primary Soviet aircraft threat was still the MIG-21. The threat has changed drastically in the last five years. New Soviet fighters are larger, faster, and more sophisticated than the MIG-21. In many respects, modern Soviet

aircraft closely resemble the new generation of U.S. fighters in physical appearance, radar technology, and weapon systems capabilities. Therefore, the cheapest means to dissimilar air combat tactics training may not be the answer for today's requirements if the resulting training is unrealistic.

The second study, titled "Realistic Training: The Key to Success in Aerial Combat," was more of a historical review of air-to-air training and subsequent force development. This study included information about the Aggressor program and emphasized realistic air combat training. It was useful background information for this study.

NON-MILITARY PUBLICATIONS

Articles relating to the subject matter of this thesis were found mostly in aviation and defense oriented periodicals not published by the military. The main sources that actually describe aircraft characteristics and capabilities in unclassified terms are Jane's All the World's Aircraft, Aviation Week and Space Technology, Air Force Magazine, Armed Forces Journal International, International Defense Review, and Marine Corps Gazette. The ever changing nature of aircraft technology and design, coupled with intelligence sensitivity of military aviation equipment, requires a thorough cross-check of information sources to determine the most accurate data available.

Jane's All the World's Aircraft, a British publication edited by John W. R. Taylor, is a world-renowned authority on

aerospace systems. This publication is continuously revised as new information is accumulated. Current excerpts are printed on a regular basis in Air Force Magazine. Once a year, these excerpts are compiled, added to previously known information, and bound into a large reference book for public sale. Certain specifics, such as thrust-to-weight ratio and turning performance rates of aircraft, are not always included. This publication is excellent for aircraft background information, discerning different series of each basic aircraft, and details concerning weight, dimensions, performance, avionics, and armament. "Some specifications are necessarily estimated or approximate."[2]

Aviation Week and Space Technology is published weekly by McGraw-Hill, Inc. This magazine covers the full spectrum of commercial and military aviation progress. Several useful articles from this publication were reviewed for this study. Information about the newer Soviet fighters, especially the MIG-31, MIG-29, and SU-27, was especially helpful in analyzing these aircraft for comparison with the F-5E. Since this magazine is published weekly, it contains the most up-to-date unclassified aviation information. "Aviation Week and Space Technology is edited for persons with active, professional, functional responsibility in aviation, air transportation, aerospace, advanced and related technologies."[3]

Another excellent literature source for this study was Air Force Magazine. Published monthly by the Air Force Association, it contained numerous factual articles about the

Aggressor program, USAF equipment and capabilities, Soviet/ Warsaw Pact equipment and capabilities, and air combat training. Much of the research information contained in this thesis was derived from this source. As mentioned earlier in this review of literature, Air Force Magazine presents excerpts from Jane's All the World's Aircraft on a regular basis.

Two defense oriented journals that provided numerous air warfare articles were Armed Forces Journal International and International Defense Review. These international journals were useful for gaining allied and sister service viewpoints about NATO-Warsaw Pact balance and air combat training programs. Most of the articles were beneficial for providing background information for this study as opposed to aircraft capability data.

The Marine Corps Gazette, published monthly by the Marine Corps Association, contained one very useful article on the MIG-29 and SU-27. This article is the source for the radar search and track ranges of these two aircraft depicted in Chapter III. This is the only unclassified source that the author found available for these radar ranges.

SUMMARY

This review of literature provides the major sources of research material available on friendly and enemy fighter

aircraft. Security classifications and the limited information available on the new Soviet fighters restricted the material available. However, unclassified data available provides sufficient information to allow for relatively accurate comparison of the F-5E with current Soviet aircraft.

The most credible sources for this study, as judged by the author, were Jane's All the World's Aircraft, Aviation Week and Space Technology, and International Defense Review. Information from these three sources was consistent. The similarity of data in these sources indicated to the author that each source used the other for information.

ENDNOTES

[1] Wood, B. K., Major, USAF. "Will Aggressor Squadrons Be Needed in the Future?" U.S. Army Command and General Staff College, Masters Thesis, 1979, p. iii.

[2] Taylor, J. W. R. "Gallery of Soviet Aerospace Weapons," Air Force Magazine, March 1983, p. 79.

[3] Aviation Week and Space Technology, November 28, 1983, p. 5.

CHAPTER III

SOVIET FIGHTER CHARACTERISTICS AND CAPABILITIES

The purpose of this chapter is to identify the major characteristics and capabilities of the following Soviet aircraft: MIG-23 (NATO Flogger), MIG-31 (NATO Foxhound), MIG-29 (NATO Fulcrum), and SU-27 (NATO Flanker). These aircraft are the most modern of the Soviet inventory and the most likely to be encountered by U.S. fighter pilots in any near-term conflict. All, except, the MIG-31, have a dual-role capability. This means that they can be used either as air-to-air combat fighters/interceptors or as air-to-surface fighter bombers. This thesis is oriented to dissimilar air combat tactics training. Therefore, this chapter will concentrate on the air-to-air capabilities of the above Soviet aircraft, not the air-to-surface capabilities.

HISTORICAL REVIEW OF FIGHTER DEVELOPMENT

In order to better understand the capabilities and limitations of Soviet aircraft, a brief review of fighter development is warranted. The Soviets develop and produce aircraft in much the same way as the United States or any other country. Generally, there will be several variants of the same basic airframe.

The need for a new aircraft is usually based upon past combat experience shortfalls, new technology, and new combat roles and tactics. First a prototype aircraft is produced in very limited numbers and tested. After the major flaws are worked out in testing, an initial production of one variant takes place.

To illustrate Soviet fighter development, the evolution of the MIG-21 (Fishbed) will be reviewed. The MIG-21 was designed on the basis of jet-to-jet combat experience during the Korean War. The initial MIG-21 is a short-range clear-weather air-to-air fighter with a range-only radar. This aircraft is known as the MIG-21F (Fishbed-C). The second in the series is the MIG-21PF (Fishbed-D) that incorporated a search/track radar, giving it a limited all-weather capability. Next is the MIG-21PM (Fishbed-F) with improved stability and increased maximum speed at low altitude. The Fishbed-H is a reconnaissance version. The MIG-21PFMA (Fishbed-J) is a multi-role development with a further improved radar, more armament, and more external fuel capacity. The MIG-21SMT (Fishbed-K) is similar to the Fishbed-J but has more internal fuel storage and improved aerodynamic form. Known as the third-generation of the MIG-21, the MIG-21bis (Fishbed-L) is a multi-role air combat fighter/ground attack version with updated avionics, improved construction standards, and increased fuel capacity. The MIG-21bis (Fishbed-N) has an increased thrust turbojet engine, and enhanced avionics, radar, and armament.

The MIG-21 is the most exported aircraft in the world and is also produced in Czechoslovakia, India, and China. The Soviets export fighter aircraft to the Warsaw Pact and third-world nations. They do not export their newest variants. They keep the newest variants for homeland defense and export older or less advanced models. Only about 700 MIG-21's are still flown by the Soviet tactical air forces. These aircraft are the multi-role Fishbed-J/K/L/N variants and the Fishbed-H reconnaissance version.[2]

One can see from this discussion that to merely refer to the MIG-21 as a Soviet fighter is misleading. The MIG-23 is also produced in several variants. The MIG-29 and SU-27 will most probably also have several variants as they mature. The remainder of this chapter lists only the air-to-air capabilities of the MIG-23, MIG-31, MIG-29, and SU-27.

MIG-23 (FLOGGER)

It is not uncommon for modern Soviet fighters to resemble U.S. built fighters in appearance and capabilities. The MIG-23 is no exception. This aircraft was originally put into production in 1967 and resembles the physical appearance of the U.S. built General Dynamics F-111. Although it is smaller than the F-111 and only has one engine, it incorporates variable-geometry wing technology similar to the F-111. The wing can be swept to 16 degrees for loitering, 45 degrees for dogfighting, or 72 degrees for high speed accelerations.[3]

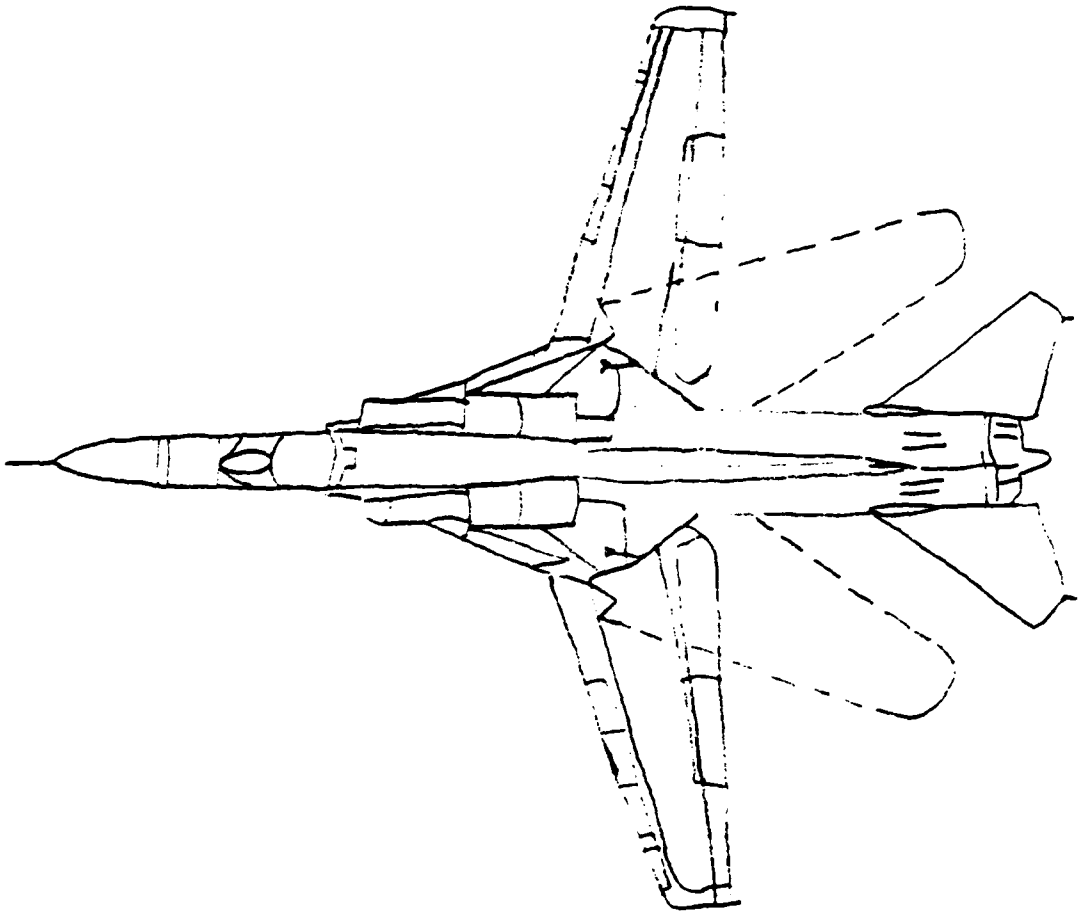

Figure 1. MIG-23 (Flogger-B/G)

Eight versions of the MIG-23 have been produced. The Flogger-B, Flogger-E, and Flogger-G are the air-to-air variants of significance to this study. More than 600 MIG-23 type aircraft have been built per year since 1978. This aircraft has replaced the MIG-21 (Fishbed) as the backbone of the Soviet air forces and is consequently the major air threat facing U.S. fighter pilots in 1984.[4]

The export air-to-air variant of the MIG-23 is the Flogger-E. This aircraft is a version of the Flogger-B but has a lower standard of radar (search range 15 nautical miles (NM), track range 10 NM) and normally carries AA-2 Atoll short-range, rear aspect, radar/infrared homing missiles. Therefore, the aircraft has neither a beyond-visual-range nor an all-aspect kill capability. If the Flogger-E were equipped with newer Soviet radars and missiles, the all-aspect kill capability of this aircraft would be enhanced. It is flown by all Warsaw Pact air forces, except Romania, and by at least nine other air forces to include Algeria, Iraq, Libya, and Cuba.[5]

It is believed that a total of about 2150 Flogger-B/G variants are in the Soviet air forces.[6] These variants are single-seat air combat fighter/interceptors with a thrust-to-weight ratio of .81:1.[7] Speed is one of the most impressive capabilities of this aircraft. Its one turbojet engine, rated at 27,500 pounds status thrust with maximum afterburning, produces a maximum speed of Mach 2.35 at altitude and Mach 1.2 at sea level.[8] With this speed, the Flogger has the potential to quickly intercept head-on targets by closing the range rapidly, run down its prey from behind, or separate from losing situations.

The Flogger-B/G has a pulse radar with capabilities similar to the U.S. built F-4. The radar search range is 46 NM, and target tracking is 29 NM. It has a limited look-down/ shoot-down capability, meaning that the MIG-23 can shoot down

another aircraft that is flying below its own altitude. This is the first Soviet fighter that has demonstrated this capability.[9]

The Flogger-B/G is equipped with one twin-barrel 23mm (Gsh-23 gun) in a belly pack, two AA-7 (NATO Apex) medium-range, all-aspect, radar/infrared homing missiles.[10] This armament combines with the radar to give these variants a beyond-visual-range, all-aspect kill capability.

When the wings are swept to 45 degrees for dogfighting, it can generate an instantaneous turn rate of 12 degrees/second. At sea level and at 72 degrees wing sweep it can only generate 11 degrees/second instantaneous turn rate.[11] Consequently, the MIG-23 is not considered, by experienced fighter pilots, to be a serious threat in a visual, turning air-to-air engagement where the number of friendly and enemy aircraft are equal.

However, the MIG-23's high speed, all-weather radar, and all-aspect beyond-visual-range (BVR) missile capability make it a good interceptor. Combine these capabilities with the large number of aircraft available and the MIG-23 is a formidable threat. These capabilities have also allowed the Soviets to drastically change their fighter tactics when compared to the earlier MIG-21 tactics.

The characteristics and capabilities of the MIG-23 are listed in Table 1. This data will be compared later with the F-5E data in Chapter IV.

TABLE 1. MIG-23 CHARACTERISTICS

SIZE: LENGTH	55 ft
SIZE: WIDTH	27 ft (Swept) 47 ft (Spread)
THRUST-TO-WEIGHT-RATIO	.81:1
SPEED	MACH 2.3
SUSTAINED TURN RATE	6 DEG/SEC (45 DEGREE WING SWEEP)
INSTANTANEOUS TURN RATE	12 DEG/SEC (45 DEGREE WING SWEEP)
RADAR	SEARCH: 46 NM TRACK: 29 NM ANGLE-TRACK
MISSILES	° MEDIUM-RANGE RADAR/ INFRARED ° SHORT-RANGE RADAR/ INFRARED
GUN	23 MM
BVR	YES
LOOK-DOWN/ SHOOT-DOWN	YES (LIMITED)

Note: Size/turn rate figures rounded to closest whole number.

MIG-31 (FOXHOUND)

"Among the most advanced recent entries into the Soviet fighter inventory...is the MIG-31, a 'true look-down/ shoot-down' fighter, similar to the F-15 Eagle,"[12] This statement was made by Colonel Donald R. Arnaiz at the Air Force Association's National Symposium on "Tactical Air Warfare," held in September, 1983, in Washington, D.C. Colonel Arnaiz is Tactical Air Command's Deputy Chief of Staff for Intelligence and is responsible for calculating the threat for Tactical Air Command. He went on to say: "The MIG-31 Foxhound...will markedly boost the Soviet Union's ability to detect and shoot down 'low-altitude penetrating aircraft, such as our bombers.'"[13]

The MIG-31 is not a totally new Soviet development. It is actually an updated intercept version of the MIG-25 Foxbat. The MIG-25 first flew in 1964 and was developed by the Soviets to intercept the U.S. B-70, high-altitude, Mach 3 bomber. The B-70 program was cancelled by President Kennedy in March, 1961.[14] Consequently, the Foxbat is designed to attack high-flying targets. It is the fastest known armed combat aircraft ever introduced into military service. The Soviets have over 200 Foxbats in operational service. It is also flown by the air forces of India, Algeria, Libya, and Syria.[15]

The first indication of the new improved Foxbat came from Lieutenant Viktor Belenko, the Soviet pilot who defected

to Japan in a Foxbat-A in September, 1976: "...the airframe of the new fighter had been strengthened to permit supersonic flight near the ground; the engines had been uprated to give 30,865 lb st [pounds static thrust] with afterburning; the avionics had been improved; and two fuselage attachments had been added to make possible the carriage of a total of six air-to-air missiles."[6]

The new improved Foxbat is designated by NATO as the MIG-31 Foxhound. It is a two-seat version of the MIG-25 and is equipped with the new engines and avionics Lieutenant Belenko described. In addition, it has an extended range capability and can now carry up to eight AA-9 medium range, all-aspect radar-guided missiles.[17]

The Foxhound is a relatively large aircraft and is designed as an interceptor, not a highly maneuverable air combat fighter. The actual turn rates for the MIG-31 are not available. However, the MIG-31 does have a high wing loading.[18] Wing loading is a primary factor affecting turn performance, can be stated as a number, and can be used to compare aircraft. Wing loading is derived by dividing the aircraft gross weight by the surface area of the wing.[19] The smaller the wing loading is, the greater the turn rate will be. Wing loading of the MIG-31 and F-5E are 101 pounds/square foot[20] and 72 pounds/square foot[21], respectively. Therefore, the MIG-31 can be expected to have a much lower turn rate capability than the

F-5E. For comparison purposes, the instantaneous and sustained turn rates of the MIG-31 will be listed as "NOT AVAILABLE."

The turn rate capability of this aircraft is not as important as its speed, radar, and missile capabilities. The Foxhound can cruise at high altitude (up to 80,000 feet), fly at high speeds (Mach 2.4), and shoot down low altitude fighter and cruise missile size targets with radar-guided missiles. This capability was successfully tested by Soviet pilots who intercepted targets with a radar signature under one square meter at altitudes below 200 feet while flying at an alternate above 20,000 feet.[22] The fire control radar of the MIG-31 can

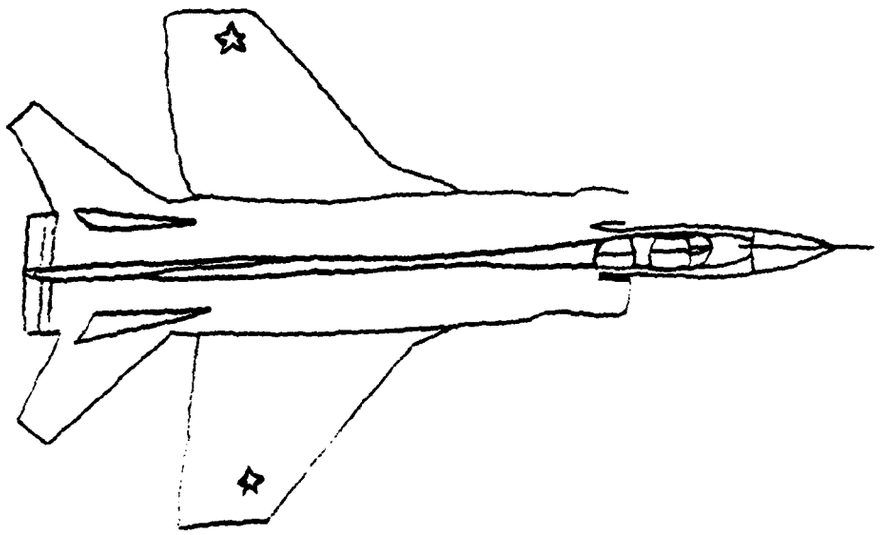

Figure 2. MIG-31 (Foxhound)

TBALE 2. MIG-31 CHARACTERISTICS

SIZE: LENGTH	78 ft
SIZE: WIDTH	46 ft
THRUST-TO-WEIGHT RATIO	.63:1
SPEED	MACH 2.4
SUSTAINED TURN RATE	NOT AVAILABLE
INSTANTANEOUS TURN RATE	NOT AVAILABLE
RADAR	SEARCH: 90 NM TRACK: 45 NM TRACK-WHILE-SCAN
MISSILES	° MEDIUM-RANGE ACTIVE ° MEDIUM-RANGE RADAR/ INFRARED ° SHORT-RANGE RADAR/ INFRARED
GUN	30 MM
BVR	YES
LOOK-DOWN/ SHOOT-DOWN	YES

Note: Size/turn rate figures rounded to closest whole number.

simultaneously display 20 targets, identify 16 targets, and track 4 targets, even in ground clutter.[23] The actual search and track ranges of the Foxhound radar are not available. However, the extended range and track-while-scan radar capabilities of the MIG-29 and SU-27 were developed and tested extensively in the MIG-31 at Vladimirovka, a test site on the Caspian Sea.[24] For comparison purposes, the SU-27 radar ranges will be substituted for the MIG-31. These radar ranges are search: 90 NM, track: 45 NM.[25] The Soviets have four operational regiments deployed so far and production is continuing.[26]

The MIG-31 Foxhound capabilities are listed in Table 2.

MIG-29 (FULCRUM)

The MIG-29 is a completely new fighter design for the Soviets. It is scheduled to enter operational service in the spring of this year. Unlike the MIG-31 which was earlier described as an interceptor, the Fulcrum will have both an air superiority and ground support capability. Since it is so new, very little confirmed informaton is available on this aircraft. However, U.S. satellites have spotted this aircraft repeatedly at the Ramenskoye flight test center as early as 1979.[27] This aircraft is of major concern because its deployment will narrow the technology gap that presently exists between U.S. air superiority fighters and earlier model Soviet air combat

fighters. This aircraft will be a potential threat to U.S. aircrews throughout the remainder of this century.

The Fulcrum is most often compared in size, weight, and even avionics to the Navy/McDonnell Douglas F-18 Hornet. Its performance is generally compared to the U.S. Air Force/ General Dynamics F-16 Falcon. Like the F-18, the Fulcrum is a single seat aircraft with a bubble canopy and has two engines.[28]

Each engine of the MIG-29 is rated at 19,000 pounds static thrust in afterburner. This gives the aircraft a thrust-to-weight ratio of 1.2:1, a maximum speed at 30,000 feet of Mach 2.3, and a maximum speed at sea level of Mach 1.2.[29]

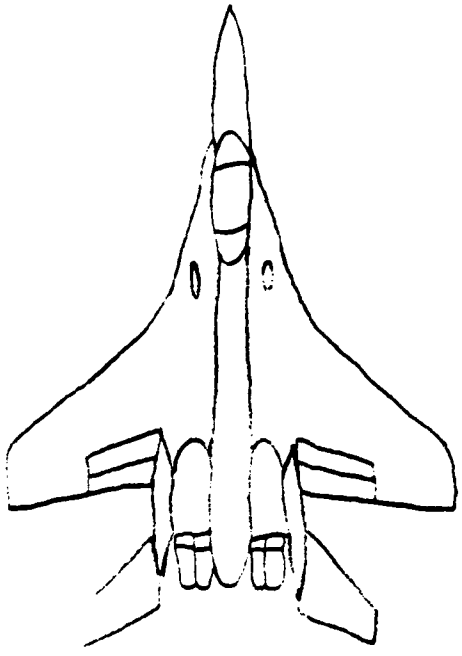

Figure 3. MIG-29 (Fulcrum)

The radar of the MIG-29 is a pulse Doppler look-down/shoot-down type with a track-while-scan capability. The track-while-scan radar allows the pilot to track and launch a missile at one target while continuing to scan for other targets. This capability is a tremendous improvement for the Soviets. The radar is reported to have a search range of 130 NM and a track range of 100 NM.[30] These ranges are significantly greater than the MIG-23 Flogger.

The armament of the MIG-29 is designed to enhance the aircraft's radar capability. It will carry the Soviet's new AA-X-9 medium-range air-to-air missile with active terminal guidance. This missile is in the final stages of development. The terminal guidance package of this missile allows the pilot to launch a missile at a target and then break off the intercept or continue firing other missiles at other targets. This concept is called "launch and leave" and is a new concept in radar-guided missiles. With previous radar-guided missiles, the pilot had to maintain radar lock-on to the target until missile impact. Research sources vary on the number of AA-X-9 missiles speculated to be carried. The least number is four; the highest is ten. However, the number of missiles carried is less important than the actual capability to fire these missiles and the reported missile range of 25 nautical miles. The MIG-29 is also said to be armed with a 30mm gun.[31]

The turn rate capability of the MIG-29 is much improved over the MIG-23 or MIG-31. This new fighter possesses wing

and fuselage design features which produce turn rate capabilities similar to U.S. modern air superiority fighters. It is reported to have a sustained turn rate of 16 degrees per second and an instantaneous rate of 21 degrees per second.[32]

The combination of thrust-to-weight ratio, high speed, radar, missile, and turn rate capability make the MIG-29 a serious air superiority challenge to U.S. fighter pilots. Figures are not available on the production rate expected for this aircraft. If, however, MIG-29 production rates approach those of earlier Soviet figures, the Fulcrum will be deployed in large quantities in the very near future.

"U.S. analysts believe that Soviet fighter production will return to its late-1970's peak of 1,200 aircraft a year as the new types become established. Output is currently estimated at 1,000 a year, a figure which encompasses the entire requirements of the Soviet Union, its Warsaw Pact allies and exports. While the new Soviet tactical aircraft are generally comparable to the latest in-service Western types in quality, higher production rates mean that the proportion of Soviet and allied units equipped with the latest type of aircraft will rise more rapidly than is possible in the West, leading to a close parity in fleet-wide technical quality by the late 1980's."[33]

The characteristics and capabilities of the MIG-29 Fulcrum are listed in Table 3.

TABLE 3. MIG-29 CHARACTERISTICS

SIZE: LENGTH	51 ft
SIZE: WIDTH	34 ft
THRUST-TO-WEIGHT RATIO	1.2:1
SPEED	MACH 2.3
SUSTAINED TURN RATE	16 DEG/SEC
INSTANTANEOUS TURN RATE	21 DEG/SEC
RADAR	SEARCH: 130 NM TRACK: 100 NM TRACK-WHILE-SCAN
MISSILES	MEDIUM-RANGE ACTIVE
GUN	30 MM
BVR	YES
LOOK-DOWN/ SHOOT-DOWN	YES

Note: Size/turn rate figures rounded to closest whole number.

SU-27 (FLANKER)

The last fighter to be addressed in this study is the SU-27 (NATO FLANKER). The SU-27, like the MIG-29, is a totally new aircraft design for the Soviets, has been under satellite observation at the Soviet flight test center of Ramenskoye for several years, has both an air superiority and ground support capability, and is scheduled to enter initial operational service this year. Early reports of this aircraft suggested a variable-geometry wing configuration similar to the F-14 Tomcat. These reports have since been discounted, and the aircraft is now believed to be in the same category as the F-15 Eagle.[34] The fact that various

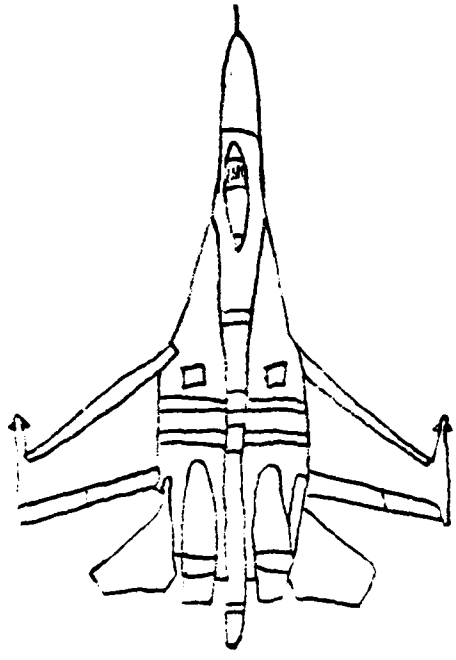

Figure 4. SU-27 (Flanker)

commercial aviation publications compare the SU-27 in size and performance to the F-15 makes coverage of this aircraft important to the purpose of this thesis. In reference to the two new Soviet fighters, the MIG-29 and SU-27, Assistant Secretary of the Air Force Alton Keel recently said that there is "reason to have concern about how long we can keep our technological edge."[35]

The Flanker is a single-seat aircraft with two high-thrust engines. The normal combat weight is 44,000 pounds with a gross takeoff weight of 63,500 pounds.[36] Each engine of the SU-27 is rated at 30,000 pounds static thrust in afterburner. This gives the aircraft a thrust-to-weight ratio of 1.2:1, and a maximum speed at sea level of Mach 1.1.[37] These speeds are similar to the earlier discussed MIG-29.

The radar of the SU-27 is of the same type as the MIG-29 but is suspected to have shorter search and track ranges. Against a single target, the radar has approximately a 90 nautical mile initial detection and track capability. In the multiple target mode it has approximately a 60 nautical mile search range and a 45 nautical mile track range.[38]

The armament of the SU-27 is again similar to the MIG-29. It can carry the new AA-X-9 missile with an active terminal radar guidance, or it may carry a mix of AA-2 Atoll, AA-7 Apex, or AA-8 Aphid missiles. The aircraft also has a 30mm cannon.[39]

TABLE 4. SU-27 CHARACTERISTICS

SIZE: LENGTH	67 ft
SIZE: WIDTH	41 ft
THRUST-TO-WEIGHT RATIO	1.2:1
SPEED	MACH 2.3
SUSTAINED TURN RATE	17 DEG/SEC
INSTANTANEOUS TURN RATE	23 DEG/SEC
RADAR	SEARCH: 90 NM TRACK: 45 NM TRACK-WHILE-SCAN
MISSILES	° MEDIUM-RANGE ACTIVE ° MEDIUM-RANGE RADAR/ INFRARED ° SHORT-RANGE RADAR/ INFRARED
GUN	30 MM
BVR	YES
LOOK-DOWN/ SHOOT-DOWN	YES

Note: Size/turn rate figures rounded to closest whole number.

The turn rate capability of the Flanker indicates that the Soviets designed this aircraft to be an air superiority fighter. The sustained turn rate is suspected to be 17 degrees/second.[40] If the projected turn rates for the SU-27 and the MIG-29 are accurate, both will be virtually equal dogfighting adversaries for either the F-15 or F-16.

The SU-27 Flanker characteristics are listed in Table 4.

SUMMARY

The discussion of Soviet aircraft characteristics and capabilities in this chapter establishes the framework for the subsequent comparisons that will follow in Chapters IV and V. Soviet design emphasis in the mid-1960's was on simplicity and affordability. Design was also limited by technical knowledge. The new Soviet aircraft appear to be strongly influenced by early-1970's U.S. design practices.[41] That is, they are larger in size, faster in speed, and more maneuverable in turning capability. Most significantly, these new fighters are equipped with advanced, long-range radars and advanced, medium-range, all-aspect missiles. As new details of modern Soviet aircraft emerge, it is evident that these new aircraft are more complex, more expensive, and more capable than their predecessors.

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CHAPTER IV

COMPARING THE F-5E WITH NEW SOVIET THREATS

Fact: The F-5E does an excellent job of simulating the MIG-21 Fishbed.[1] Question: Can the F-5E simulate the new Soviet threats--MIG-23, MIG-31, MIG-29, and SU-27? The purpose of this chapter is to determine if the F-5E possesses shortfalls in simulating these new Soviet fighters based solely upon the characteristics and capabilities discussed in Chapter III. The chapter will first present an explanation and the significance of each characteristic and capability analyzed in this study. The remainder of this chapter describes the F-5E, upgraded F-5E, and MIG-21 aircraft, establishes a standard of comparison, and presents the actual comparison results.

SIGNIFICANCE OF THE CHARACTERISTICS AND CAPABILITIES

The ten characteristics and capabilities selected for comparison are common to other aircraft comparison analysis. Each characteristic and capability will be discussed separately with emphasis on why each is significant to this study.

Size is important because it affects visual detection. The range of visual detection and pilot ability to maintain

visual contact with an aircraft determines offensive and defensive air combat maneuvers. As size is increased, visual detection range and ability to continue to maintain visual contact is improved. Conversely, visual detection range and ability to maintain visual contact of smaller aircraft in dogfight situations diminishes. Thus originated such common expressions as "Lose sight, lose fight" and "You can't fight what you can't see." The latter situation was experienced in Vietnam where Soviet built fighters were much smaller than American fighters.

Also, the size of an aircraft generally influences the radar cross section of that aircraft. The radar cross section in turn affects radar detection range. For example, an air intercept radar will detect a large bomber-type aircraft (B-52) at a greater range than it will detect a small fighter-type aircraft (F-5E). Radar detection range influences intercept tactics.

Thrust-to-weight ratio is a means to assess an aircraft's ability to accelerate, climb or sustain a turn. For example, if two aircraft with thrust-to-weight ratios of 1.0:1 and 0.57:1, respectively, are in a slow speed dogfight against each other, the aircraft with the 1.0:1 thrust-to-weight ratio will be capable of accelerating and/or gaining altitude more quickly than the aircraft with a 0.57:1 thrust-to-weight ratio.

Speed for this study refers only to high altitude Mach number. Maximum speed at sea level was included in

Chapter III for discussion purposes only. The potential of an aircraft to quickly intercept head-on targets by closing the range rapidly, run down escaping targets from a tail chase, or separate from losing/stagnated situations is directly related to speed.

Sustained turn rate is the maximum turn rate, measured in degrees per second, that an aircraft can maintain without losing energy. This rate changes with altitude, speed, gravity force (G), and thrust-to-weight ratio. For this study, sustained turn rate is measured at 15,000 feet altitude and Mach 0.9 speed. Sustained turn rate gravity force is different for each aircraft since it is dependent upon aircraft airframe limitations and thrust-to-weight ratios. In a prolonged dogfight situation, the aircraft with the higher sustained turn rate potential normally has the advantage.

Instantaneous turn rate is the quickest, tightest, turn that an aircraft can achieve at any given instant. It provides an indication of an airplane's maximum capability.[2] This turn rate cannot be maintained because energy will be lost rapidly until a sustained turn rate energy state is achieved. The greater the instantaneous turn rate an aircraft possesses the faster a pilot can generate his initial basic fighter maneuver (BFM), be it offensive or defensive.

Radar capability varies from range only, where range to a single target is the only information the pilot receives

in the cockpit, to track-while-scan, where the pilot receives range, altitude, speed, and heading of the tracked target while continuing to scan for other targets. The search and track ranges of a radar, as well as the radar capability to detect targets below the interceptor aircraft's altitude (look-down), are important characteristics in the modern day air-to-air combat arena. A pilot flying an aircraft that possesses a radar with a search range of 80 NM, a track range of 40 NM, and a look-down capability, has a tremendous advantage over a pilot flying an aircraft with a 20 NM range only radar.

Missiles are generally classified according to three characteristics: aerodynamic range, guidance sensor, and launch aspect. Specific ranges of a missile are normally classified. Therefore, for this study the following distance parameters apply: short range--½ NM to 5 NM, medium range--5 NM to 25 NM, and long range--25 NM to 100 NM.

Guidance sensors are either radar homing, infrared homing, or active guidance. Infrared homing missiles (heat seeking) home in on the infrared or heat source from the target aircraft. Active guidance missiles have a self-contained radar and do not necessarily use the launching aircraft's radar data after launch. Both the infrared homing and active guidance missiles are known as "launch and leave" missiles since the launching aircraft is not required to guide the missile after launch.

Launch aspect refers to the angle from the target from which a missile can be launched and successfully guided. All-aspect means that the missile can be guided from any angle around the target; i.e., head-on (180 degree aspect), beam (90 degree aspect), tail (0 degree aspect), or any aspect in between. Rear aspect means that the missile can only be successfully guided from the tail of the target, plus or minus a set number of degrees; i.e., 30 degrees either side of the tail.

The gun on an aircraft is considered a short-range weapon that is normally used only in dogfight situations. Whether the gun is 20mm, 23mm, or 3mm is not significant to this study. Although the range for a 30mm gun is greater than the range of a 20mm gun, this difference is easily simulated by the pilot using the aircraft's lead computing optical sight system.

Beyond-visual-range (BVR) capability means that a missile can be fired at a target that is outside the pilot's visual detection range, for example, 15 NM.

Look-down/shoot-down refers to an interceptor system which can detect, track, and shoot down a low-altitude target from a higher altitude under conditions in which ground radar return (ground clutter) would preclude success with a conventional airborne radar system.[3]

F-5E (TIGER II)

The Northrop F-5E Tiger II is a single-seat, twin-engine, [illegible] visual flight rules day/night fighter with

limited all-weather capability. The aircraft first flew in August, 1972. It was developed primarily to provide American allies with an uncomplicated air-superiority tactical fighter which would be relatively inexpensive to operate and maintain. Design emphasis was placed on maneuverability rather than high speed.[4]

The Aggressor F-5E's are standard production models. The only modification to the aircraft is the exterior paint. Aggressor F-5E's are camouflaged in several different paint schemes to visually simulate the late-model MIG threats. Also, the serial number of the aircraft, which is traditionally displayed on the tail of American aircraft, has been painted in large numerals on both sides of the forward fuselage. Again, this is to more accurately simulate the MIG threat in a visual-dogfight environment.

The F-5E was selected as the aircraft for the Aggressor mission because it is about the same size as and has performance characteristics very similiar to the MIG-21. The MIG-21

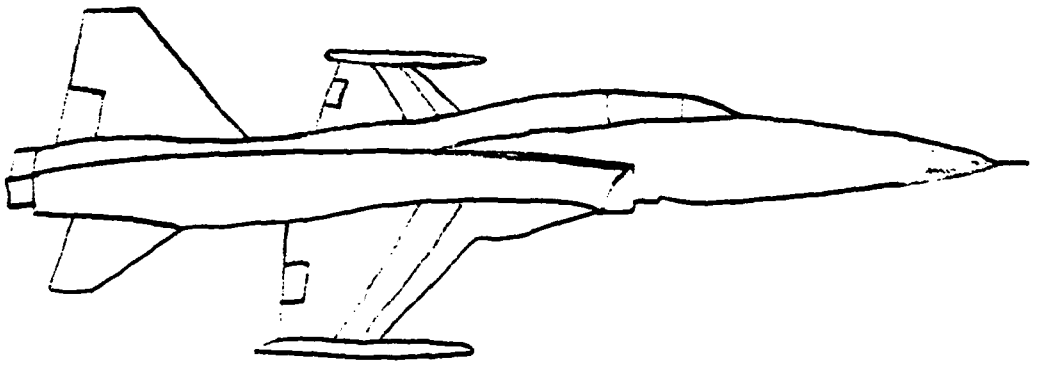

Figure 3. F-5E (Tiger II)

TABLE 5. F-5E CHARACTERISTICS

SIZE: LENGTH	47 ft
SIZE: WIDTH	27 ft
THRUST-TO-WEIGHT RATIO	0.57:1
SPEED	MACH 1.6
SUSTAINED TURN RATE	9 DEG/SEC
INSTANTANEOUS TURN RATE	17 DEG/SEC
RADAR	SEARCH: 20 NM TRACK: 10 NM RANGE ONLY
MISSILES	SHORT-RANGE INFRARED
GUN	20 MM
BVR	NO
LOOK-DOWN/ SHOOT-DOWN	NO

Note: Size/turn rate figures rounded to closest whole number.

was the primary Soviet fighter threat when the Aggressor squadrons were organized in 1972. Availability of the aircraft, as well as its relatively inexpensive operation and maintenance costs, were also factors in choosing the F-5E.

The characteristics and capabilities of the F-5E are depicted in Table 5.

MIG-21 (FISHBED)

The MIG-21 is a single-seat, single-engine, VFR day/night fighter with limited all-weather capability. The aircraft is small in size when compared to modern day fighters. The combination of its small size and smokeless engine attributed much to the success of this aircraft in Vietnam. "As a result [of its size and smokeless engine], many kills were obtained by the enemy totally undetected until it was too late to react."[5] The Soviets produced an enormous number of these aircraft. Although the total number produced is not known by the free world, this jet fighter has been flown by at least 36 air forces.[6] A detailed description of the various models and characteristics of the MIG-21 was presented in Chapter III.

The characterisitcs and capabilities of the MIG-21 are depicted in Table 6.

TABLE 6. MIG-21 CHARACTERISTICS

SIZE: LENGTH	52 ft
SIZE: WIDTH	23 ft
THRUST-TO-WEIGHT RATIO	.81:1
SPEED	MACH 2.1
SUSTAINED TURN RATE	8 DEG/SEC
INSTANTANEOUS TURN RATE	16 DEG/SEC
RADAR	SEARCH: 18 NM TRACK: 12 NM RANGE ONLY
MISSILES	SHORT-RANGE INFRARED SHORT-RANGE RADAR
GUN	23 MM
BVR	NO
LOCK-DOWN/ SHOOT-DOWN	NO

Note: Size/turn figures rounded to closest whole number.

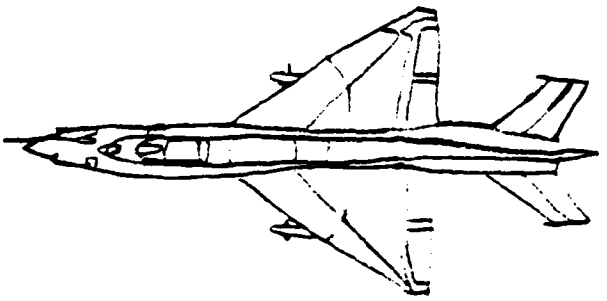

Figure 6. MIG-21 (Fishbed)

ESTABLISHMENT OF STANDARD

The remainder of this chapter comprises a series of aircraft characteristic and capability comparisons. The goal of these comparisons is to determine what shortfalls, if any, the F-5E would possess if this aircraft were tasked to simulate any of the new Soviet fighters previously discussed. Before shortfalls can be determined, a standard of measurement must be established. Table 7 compares the F-5E and MIG-21 to establish this standard. These two aircraft were selected based upon the fact that the F-5E does an excellent job of simulating the MIG-21.

TABLE 7. F-5E AND MIG-21 COMPARISON (STANDARD)

CHARACTERISTIC OR CAPABILITY	F-5E	MIG-21	DIFFERENCE	STANDARD DEVIATION RANGE (%)	RAW DATA RANGE
SIZE: LENGTH	47 ft	52 ft	5 ft (11%)	(0%-21%)	(37 ft-57 ft)
SIZE: WIDTH	27 ft	23 ft	4 ft (15%)	(0%-25%)	(21 ft-33 ft)
THRUST-TO-WEIGHT RATIO	.57:1	.81:1	.24 (42%)	0%-52%	(.28 - .86)
SPEED	MACH 1.6	MACH 2.1	.5 MACH (31%)	0%-41%	(1.0 - 2.2)
SUSTAINED TURN RATE	9 DEG/SEC	8 DEG/SEC	1 DEG (1%)	0%-11%	(7 - 11 DEG)
INSTANTANEOUS TURN RATE	17 DEG/SEC	16 DEG/SEC	1 DEG (6%)	0%-16%	(4 - 20 DEG)
RADAR	SEARCH: 20 NM TRACK: 10 NM RANGE ONLY	SEARCH: 18 NM TRACK: 12 NM RANGE ONLY	2 NM (10%) 2 NM (20%) NONE	0%-20% 0%-30% N/A	(16 - 24 NM) (7 - 13 NM) N/A
MISSILES	SR/IR	SR/IR SR/R	SR/R (+)	N/A	N/A
GUN	20 MM	23 MM	23 MM (+)	N/A	N/A
BVR	NO	NO	NONE	N/A	N/A
LOOK-DOWN/ SHOOT-DOWN	NO	NO	NONE	N/A	N/A

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

The data from the "Standard Deviation Range" (SDR) column of Table 7 will be carried over to all subsequent comparison tables in Chapter IV. Where comparison of characteristics and capabilities can be measured as a percentage, the SDR will be expressed as a high and low percentage; i.e., plus 10 percent of the difference derived from the F-5E and MIG-21 comparison.[7] For example, the difference in length between the F-5E and MIG-21 is 11 percent; therefore, the SDR is 0 percent to 21 percent. When subsequent length comparisons of the F-5E and new Soviet aircraft fall outside this range, it will be considered a "shortfall." However, where characteristic and capability comparisons cannot be expressed as a percentage, the standard deviation range is not applicable. In this case, the actual difference is used to determine if a shortfall exists. For example, for beyond-visual-range capability, Table 8 shows: F-5E = NO, MIG-23 = YES, difference is YES, and shortfall is YES. The remainder of this chapter identifies the number and type of shortfalls that the F-5E possesses in simulating new Soviet fighters. These shortfalls will be examined for task relationships in Chapter V.

F-5E AND MIG-23 COMPARISON

The Aggressors have been tasked by fighter units to simulate the MIG-23 during dissimilar air combat tactics training.[8] As Table 8 depicts, the F-5E possesses shortfalls in 8 out of 10 categories.

TABLE 8. F-5E AND MIG-23 COMPARISON

CHARACTERISTIC OR CAPABILITY	F-5F	MIG-23	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	55 ft	8 ft (17%)	0% - 21%	YES
WIDTH	27 ft	Swept(72°):27 ft Spread(45°):47 ft	0 ft (0%) 20 ft (74%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.57:1	.81:1	.24 (42%)	0% - 52%	NO
SPEED	MACH 1.6	MACH 2.3	.7 MACH (44%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	(45° Spread) 6 DEG/SEC	3 DEG (33%)	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	(45° Spread) 12 DEG/SEC	5 DEG (29%)	0% - 16%	YES
RADAR	SEARCH: 20 NM TRACK: 10 NM RANGE ONLY	SEARCH: 46 NM TRACK: 29 NM ANGLE-TRACK	26 NM (130%) 19 NM (190%) ANGLE-TRACK	0% - 20% 0% - 30% N/A	YES
MISSILES	SR/IR	MR/R/IR SR/R SR/IR	MR/R/IR (-) SR/R (+)	N/A	YES
GUN	20 MM	23 MM	23 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES (LIMITED)	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

For beyond-visual-range intercept tactics training, the F-5E closely approximates the MIG-23 in size when the MIG has the wings swept to 72 degrees. However, since the intercept ranges are by definition beyond-visual-range, this similarity is academic. The F-5E cannot simulate the MIG-23's capabilities of speed, radar, missiles, BVR, or look-down/ shoot-down.

In visual air combat maneuver training, the MIG-23 will normally have the wings set to 45 degrees to increase the turn rate. In this environment, the F-5E is too small and the turn rates are not comparable.

F-5E AND MIG-31 COMPARISON

Although the Aggressors have never been tasked to simulate the MIG-31, the aircraft is included in this study because it is a potential future threat to U.S. fighter aircrews. This study focuses on realistic air combat tactics training for air combat threat aircraft in the Soviet/Warsaw Pact inventory most likely to be encountered.

Table 9 illustrates that the F-5E possesses shortfalls in 8 out of 10 categories when attempting to simulate the MIG-31. The sustained and instantaneous turn rates of the F-5E are rated as shortfalls based upon the high wing loading figure of the MIG-31 as explained in Chapter III. The remaining shortfalls are self-explanatory. Based solely upon this comparison of characteristics and capabilities, the F-5E is neither a good

intercept tactics nor visual air combat maneuvering simulator for the MIG-31.

F-5E AND MIG-29 COMPARISON

Using the 10 percent deviation range, the F-5E is very close in size to the MIG-29. The width of the MIG-29 is outside the established standard deviation range by only one percent. Therefore, even though the size of the F-5E is rated a shortfall in simulating the MIG-29, this shortfall would be less significant if the other shortfalls were also very close. However, the other shortfalls depicted in Table 10 are well outside the standard deviation range. From this comparison, the F-5E possesses shortfalls in 9 of 10 categories.

F-5E AND SU-27 COMPARISON

The only capability the F-5E can reasonably simulate for the SU-27 is the gun. All other comparison differences are well outside the standard deviation range. The F-5E possesses shortfalls in 9 of 10 categories in simulating the SU-27, based upon characteristic and capability comparison data, as shown in Table 11.

TABLE 9. F-5E AND MIG-31 COMPARISON

CHARACTERISTIC OR CAPABILITY	F-5E	MIG-31	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	78 ft	31 ft (66%)	0% - 21%)	YES
SIZE: WIDTH	27 ft	46 ft	19 ft (70%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.57:1	.63:1	.06 (10%)	0% - 52%	NO
SPEED	MACH 1.6	MACH 2.4	.8 MACH (50%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	NOT AVAILABLE	N/A	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	NOT AVAILABLE	N/A	0% - 16%	YES
RADAR	SEARCH: 20 NM TRACK: 10 NM RANGE ONLY	SEARCH: 90 NM TRACK: 45 NM TRACK-WHILE-SCAN	70 NM (350%) 35 NM (350%) TRACK-WHILE-SCAN N/A	0% - 20% 0% - 30%	YES
MISSILES	SR/IR	MR/R/IR SR/R SR/IR	MR/R/IR (-) SR/R (+)	N/A	YES
GUN	20 MM	30 MM	30 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

TABLE 10. F-5E AND MIG-29 COMPARISON

CHARACTERISTIC OR CAPABILITY	F-5E	MIG-29	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	51 ft	4 ft (8%)	0% - 21%	YES
SIZE: WIDTH	27 ft	34 ft	7 ft (26%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.57:1	1.2:1	.63 (111%)	0% - 52%	YES
SPEED	MACH 1.6	MACH 2.3	.7 MACH (44%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	16 DEG/SEC	7 DEG (78%)	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	21 DEG/SEC	4 DEG (24%)	0% - 16%	YES
RADAR	SEARCH: 20 NM TRACK: 10 NM RANGE ONLY	SEARCH: 130 NM TRACK: 100 NM TRACK-WHILE-SCAN	110 NM (550%) 90 NM (900%) TRACK-WHILE-SCAN	0% - 20% 0% - 30% N/A	YES
MISSILES	SR/IR	MR/A	MR/A (-)	N/A	YES
GUN	20 MM	30 MM	30 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/ACtive)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

TABLE 11. F-5E AND SU-27 COMPARISON

CHARACTERISTIC OR CAPABILITY	F-5E	SU-27	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	67 ft	20 ft (43%)	0% - 21%	YES
SIZE: WIDTH	27 ft	41 ft	14 ft (52%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.57:1	1.2:1	.63 (111%)	0% - 52%	YES
SPEED	MACH 1.6	MACH 2.3	.7 MACH (44%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	17 DEG/SEC	8 DEG (89%)	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	23 DEG?SEC	6 DEG (35%)	0% - 16%	YES
RADAR	SEARCH: 20 NM TRACK: 10 NM RANGE ONLY	SEARCH: 90 NM TRACK: 45 NM TRACK-WHILE-SCAN	70 NM (350%) 34 NM (350%) TRACK-WHILE-SCAN	0% - 20% 0% - 30% N/A	YES
MISSILES	SR/IR	MR/A, MR/R/IR SR/A, SR/R SR/IR	MR/A (-) MR/R/IR (-) SR/R (+)	N/A	YES
GUN	20 MM	30 MM	30 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5F

UPGRADED F-5E

The Aggressor F-5E's are forecasted to be upgraded with a more capable radar and a short-range, all-aspect, heat-seeking missile capability in the 1986 timeframe. The Aggressor squadrons at Nellis AFB, Nevada, have already received the upgraded radar in six new F-5F aircraft.[9]

The upgraded radar has a search range of 40 nautical miles and a track range of 10 nautical miles. In addition, the new radar has an angle-track capability. Angle-track allows the pilot to track targets, inside of 10 nautical miles, that are at angles of up to 45 degrees off the upgraded F-5's nose. The former F-5E radar could only track targets that were directly on the nose. This angle-track capability should give the pilot earlier situation awareness, aid in avoiding head-on, close-proximity passes, and allow for more accurate firing simulation of some Soviet medium-range, all-aspect, radar-guided missiles.

Aggressor pilots who have flown the upgraded F-5E state that the power of the radar is weak beyond 20 nautical miles search and few radar contacts are achieved outside this range. In addition, in a look-down intercept situation, where ground clutter is a factor, the radar scope gets flooded with radar returns from the ground. However, the pilots claim that the radar's ability to detect targets in a look-up situation is greatly improved inside of 20 nautical miles where the radar

has increased power. This earlier detection of targets allows the pilots to more quickly track targets inside of 10 nautical miles and subsequently simulate the firing of a radar-guided missile.[10]

The short-range, all-aspect, heat-seeking missile will allow Aggressor pilots to more accurately simulate the modern dogfight missile capabilities of Soviet fighters since the present F-5E missile capability is rear-aspect only.

Table 12 depicts the upgraded F-5E characteristics. The only changes from the present F-5E are the radar and missile capabilities.

UPGRADED F-5E AND MIG-23 COMPARISON

The present F-5E possesses shortfalls in 8 of 10 categories when attempting to simulate the MIG-23. Table 13 illustrates that the upgraded F-5E is better, with shortfalls in 5 of 10 categories. The F-5E's visual dogfight simulation of the MIG-23 has not improved by the addition of the new radar and more capable missile. Size, speed, and turn rate differences remain as problems for F-5E accurate simulation of the MIG-23. The radar capability is still a shortfall because the radar track range has not increased. However, the improved ability to detect targets inside 20 nautical miles (angle-track targets inside 10 nautical miles), simulate firing of AA-7 Apex radar-guided missiles beyond-visual-range, and simulate limited look-down/shoot-down capability has more closely aligned the F-5E to the MIG-23.

TABLE 12. UPGRADED F-5E CHARACTERISTICS

SIZE: LENGTH	47 ft
SIZE: WIDTH	27 ft
THRUST-TO-WEIGHT RATIO	.57:1
SPEED	MACH 1.64
SUSTAINED TURN RATE	9 DEG/SEC
INSTANTANEOUS TURN RATE	17 DEG/SEC
RADAR(UPGRADED)	SEARCH: 40 NM TRACK: 10 NM ANGLE-TRACK
MISSILES (UPGRADED)	SHORT-RANGE INFRARED (ALL ASPECT)
GUNS	20 MM
BVR	NO
LOOK-DOWN/ SHOOT-DOWN	NO

Note: Size/turn rate figures rounded to closest whole number.

TABLE 13. UPGRADED F-5E AND MIG-23 COMPARISON

CHARACTERISTIC OR CAPABILITY	F-5E	MIG-23	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	55 ft	8 ft (17%)	0% - 21%	YES
SIZE: WIDTH	27 ft	Swept(72%): 27 ft Spread(45%):47 ft	0 ft (0%) 25 ft (74%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.57:1	.81:1	.24 (42%)	0% - 52%	NO
SPEED	MACH 1.6	MACH 2.3	.7 MACH (44%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	(45° Spread) 6 DEG/SEC	3 DEG (33%)	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	(45° Spread) 12 DEG/SEC	5 DEG (29%)	0% - 16%	YES
RADAR	SEARCH: 40 NM TRACK: 10 NM ANGLE-TRACK	SEARCH: 46 NM TRACK: 29 NM ANGLE-TRACK	6 NM (15%) 19 NM (190%)	0% - 20% 0% - 30% N/A	YES
MISSILES	SR/IR	MR/R/IR SR/R	MR/R/IR (+) SR/R (+)	N/A	NO
GUN	20 MM	23 MM	23 MM (+)	N/A	NO
AVR	NO	YES	YES (+)	N/A	NO
LOOK-DOWN/ SHOOT-DOWN	NO	YES (LIMITED)	YES (+)	N/A	NO

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5F
(+) Can be simulated by F-5F

UPGRADED F-5E AND MIG-31, MIG-29, AND SU-27 COMPARISONS

The upgraded F-5E shows no significant improvement over the present F-5E in simulating either the MIG-31, MIG-29, of SU-27. The number of shortfalls for each comparison remains the same. This information is depicted in Tables 14, 15, and 16.

SUMMARY

This chapter compared the present Aggressor F-5E, MIG-23, MIG-31, MIG-29, and SU-27 characteristics and capabilities. Based upon these comparisons the F-5E possesses shortfalls in the following number of categories when attempting to simulate the new Soviet aircraft: MIG-23, 8 of 10; MIG-31, 8 of 10; MIG-29, 9 of 10; and SU-27, 9 of 10. Similar comparisons were subsequently made with the upgraded F-5E being substituted for the present F-5E. These results were as follows: MIG-23, 5 of 10; MIG-31, 8 of 10; MIG-29, 9 of 10; and SU-27, 9 of 10.

Based solely upon these characteristic and capability comparisons, the present F-5E appears to possess too many shortfalls to simulate any of the new Soviet threats discussed in this study. The upgraded F-5E reduced the number of shortfalls when compared to the MIG-23. However, the number of shortfalls remained the same when compared to the other aircraft.

TABLE 14. UPGRADED F-5E AND MIG-31 COMPARISON

CHARACTERISTIC OR CAPABILITY	UPGRADED F-5E	MIG-31	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	78 ft	31 ft (66%)	0% - 21%	YES
SIZE: WIDTH	27 ft	46 ft	19 ft (70%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.57:1	.63:1	.06 (10%)	0% - 52%	NO
SPEED	MACH 1.6	MACH 2.4	.8 MACH (50%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	NOT AVAILABLE	N/A	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	NOT AVAILABLE	N/A	0% - 16%	YES
RADAR	SEARCH: 40 NM TRACK: 10 NM ANGLE-TRACK	SEARCH: 90 NM TRACK: 45 NM TRACK-WHILE-SCAN	50 NM (125%) 35 NM (350%) TRACK-WHILE-SCAN N/A	0% - 20% 0% - 30%	YES
MISSILES	SR/IR (ALL-ASPECT)	MR/A MR/R/IR SR/R, SR/IR	MR/A (-) MR/R/IR (+) SR/R (+)	N/A	YES
GUN	20 MM	30 MM	30 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

TABLE 15. UPGRADED F-5E AND MIG-29 COMPARISON

CHARACTERISTIC OR CAPABILITY	UPGRADED F-5E	MIG-29	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	51 ft	4 ft (8%)	0% - 21%	YES
SIZE: WIDTH	27 ft	34 ft	7 ft (26%)	0% - 25 %	
THRUST-TO-WEIGHT RATIO	.57:1	1.2:1	.63 (111%)	0% - 52%	YES
SPEED	MACH 1.6	MACH 2.3	.7 MACH (44%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	16 DEG/SEC	7 DEG(78%)	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	21 DEG/SEC	4 DEG(24%)	0% - 16%	YES
RADAR	SEARCH: 40 NM TRACK: 10 NM ANGLE-TRACK	SEARCH: 130 NM TRACK, 100 NM TRACK-WHILE-SCAN	90 NM(225%) 90 NM(900%) TRACK-WHILE-SCAN	0% - 20% 0% - 30% N/A	YES
MISSILES	SR/IR (ALL-ASPECT)	MR/A	MR/A (-)	N/A	YES
GUN	20 MM	30 MM	30 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

TABLE 16. UPGRADED F-5E AND SU-27 COMPARISON

CHARACTERISTIC OR CAPABILITY	F-5E	SU-27	DIFFERENCE	STANDARD DEVIATION RANGE	SHORTFALL
SIZE: LENGTH	47 ft	67 ft	20 ft (43%)	0% - 21%	YES
SIZE: WIDTH	27 ft	41 ft	14 ft (52%)	0% - 25%	
THRUST-TO-WEIGHT RATIO	.47:1	1.2:1	.63 (111%)	0% - 52%	YES
SPEED	MACH 1.6	MACH 2.3	.7 MACH (44%)	0% - 41%	YES
SUSTAINED TURN RATE	9 DEG/SEC	17 DEG/SEC	8 DEG (89%)	0% - 11%	YES
INSTANTANEOUS TURN RATE	17 DEG/SEC	23 DEG/SEC	6 DEG (35%)	0% - 16%	YES
RADAR	SEARCH: 40 NM TRACK: 10 NM ANGLE - TRACK	SEARCH: 90 NM TRACK. 45 NM TRACK-WHILE-SCAN	50 NM (125%) 34 NM (350%) TRACK-WHILE-SCAN	0% - 20% 0% - 30% N/A	YES
MISSILES	SR/IR (ALL-ASPECT)	MR/A MR/R/IR SR/R SR/IR	MR/A (-) MR/R/IR (+) SR/R (+)	N/A	YES
GUN	20 MM	30 MM	30 MM (+)	N/A	NO
BVR	NO	YES	YES (-)	N/A	YES
LOOK-DOWN/ SHOOT-DOWN	NO	YES	YES (-)	N/A	YES

LEGEND: SR/R (Short-Range/Radar)
SR/IR (Short-Range/Infrared)
MR/R/IR (Medium-Range/Radar/Infrared)
MR/A (Medium-Range/Active)

(-) Cannot be simulated by F-5E
(+) Can be simulated by F-5E

ENDNOTES

[1] Van Guilder, W. C. "Realistic Training: The Key to Success in Aerial Combat," MMAS Thesis, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, 1979, p. 43.

[2] U.S. Air Force, "Aircraft Comparison Techniques and Energy Maneuverability," 425th FWIC Air Attack Manual 1-1, September 14, 1978, p. 41.

[3] Peterson, P. A. "Soviet Air Power and the Pursuit of New Military Options," Studies in Communist Affairs. Volume 3, Department of the Air Force, September 14, 1983, p. 19.

[4] Taylor, J. W. R., Editor. "Gallery of USAF Weapons," Air Force Magazine, May 1983, p. 148.

[5] Grasset, P. "Dissimilar Air Combat Training--A Revolution in Realism," International Defense Review, 6/1975, p. 825.

[6] Taylor, J. W. R., Editor. "Gallery of Soviet Aerospace Weapons," Air Force Magazine, March 1983, p. 81.

[7] The rationale for using a 10 percent deviation range was explained in the methodology section of Chapter I.

[8] Based on the author's three years experience as an Aggressor pilot and interviews with current 64th FWS Aggressor pilots, February 23, 1984.

[9] Visit to 64th FWS at Nellis AFB, Nevada, Febraury 23, 1984.

[10] Interview with 64th FWS Aggressor pilots, February 23, 1984.

CHAPTER V

ANALYSIS OF AIR COMBAT TRAINING TASKS

The purpose of this chapter is to analyze the F-5E's and upgraded F-5E's capability to simulate modern Soviet threat air combat training tasks. The aircraft characteristic and capability comparisons in Chapter IV are insufficient by themselves to determine if the F-5E and upgraded F-5E can perform as realistic threat simulators for the Soviet fighters considered in this study. Therefore, the shortfalls determined in Chapter IV will be integrated with air combat training tasks to yield a more accurate, in-depth analysis.

SIGNIFICANCE OF AIR COMBAT TASKS

An aircraft's characteristics and capabilities definitely influence, if not determine, the type of intercept tactics a pilot will fly, the type of air combat maneuvers he will use in a visual dogfight, and when and how he will employ his weapons. Fighter pilots train to defeat enemy tactics, maneuvers, and weapons, not each individual aircraft characteristic and capability. Air combat training is divided into training tasks.

The four modern Soviet fighters included in this study have the capability to accomplish the following six air combat tasks: (1) look-up intercepts, 2) look-down intercepts,

(3) visual air combat maneuvers, (4) radar missile attacks, (5) infrared missile attacks, and (6) gun attacks. Therefore, for an aircraft to be accepted as a realistic threat simulator, it must be able to accomplish all of these tasks. The data in Chapter IV will be used to determine if the F-5E and upgraded F-5E are capable of performing each task. If these aircraft can accomplish some of the tasks, but not all of them, they may be able to serve as part-task simulators. For example, the upgraded F-5E may be able to simulate MIG-23 tactics, but not visual air combat maneuvering.

To be a well-trained air superiority fighter pilot, one must be proficient in defeating all six task categories. The normal sequence of a successful air combat engagement progresses from a BVR intercept, to a dogfight, to a weapon employed within the correct parameters. The more realistic the enemy aircraft and tactics are in training, the more prepared the fighter pilot will be in actual combat. Said another way: "By training against the most accurate possible representation of an adversary, the most valuable training is accomplished."[1]

DESCRIPTION OF AIR COMBAT TASKS

During air combat tactics training, as in actual combat, the friendly and threat aircraft are separated by some extended range, for example 30 to 50 nautical miles. While the aircraft close the range of each other, they will either fly a look-up or look-down intercept.

A look-up intercept occurs when the target aircraft's altitude is above the interceptor's altitude; i.e., target is at 20,000 feet altitude and interceptor is at 10,000 feet altitude. During this type of intercept, the interceptor's radar will be searching against a sky background for the target. The radar scope will be relatively clear of returns because the radar energy will have nothing to reflect off of except airborne objects. There is a good chance that the interceptor's radar will detect the target, track the target, and that the pilot can simulate a radar-guided missile.

In a look-down intercept, the opposite situation occurs. The target may now be at 10,000 feet and the interceptor at 20,000 feet. The interceptor's radar will be searching against a ground background for the target. The radar scope will be cluttered with returns from the ground since the radar energy will be reflected. It will be extremely difficult for the pilot to discriminate which return is actually the target.

This ground return problem is characteristic of pulse radars. Pulse radars send out radio energy and display all returned energy on the radar scope. The upgraded F-5E and MIG-23 radars are of this type. Pulse Doppler radars send out energy but then process the returned energy through a computer. The computer displays synthetic targets on the radar scope of only those objects that are moving faster than

a preset velocity. Therefore, the static ground returns are not displayed, the radar scope is clutter free, and the moving target is easier to detect. The MIG-31, MIG-29, and SU-27 have pulse Doppler radars.

Following the intercept, when visual contact is established, the pilots will engage in either neutral, offensive, or defensive air combat maneuvering. If the aircraft pass opposite each other, close to 180 degrees angle-off, the engagement start is neutral. If the engagement starts with one aircraft behind the other, then the aircraft that is behind is offensive and the aircraft in front is defensive. For training purposes, these attacks can be set up visually without accomplishing the intercept first. If an aircraft can simulate one of the visual attacks, it can simulate the other two as well. Consequently, neutral, offensive, and defensive attacks are grouped under a single heading, "Visual Air Combat Maneuvers."

Radar missile attacks include radar-guided missile and active terminal guidance missile firings. These missile capabilities were explained in Chapter III. The importance of these missile attacks is that they can be performed beyond-visual-range. A successful radar missile attack can destroy the target at long-range during the intercept phase.

Infrared missile employment occurs at closer ranges than radar missile firings and normally during the visual air combat maneuvering phase. There are three main reasons for this. First, the missile's infrared seeker has a limited

detection range. Second, the aerodynamic range of the missile is limited. And lastly, the missile is more capable of maneuvering against a hard turning target and does not require a radar lock-on to guide it. It is a "launch and leave" missile.

The gun is a short-range weapon that is used during close-in maneuvering. It is normally used as a last resort when missile parameters cannot be achieved or all missiles have been fired.

ANALYSIS OF WHICH AIR COMBAT TASKS F-5E CAN SIMULATE

Table 17 depicts the air combat training tasks of which the F-5E is capable of simulating for each Soviet fighter. A YES indicates that the F-5E can simulate the task. A NO means that the F-5E cannot simulate the task. The YES and NO designations are based upon the results of the characteristic and capability comparisons discussed in Chapter IV.

The F-5E can simulate 2 of 6 tasks for the MIG-23, MIG-31, MIG-29, and SU-27. These two tasks are the same for all four aircraft and are the infrared missile attacks and gun attacks.

The F-5E cannot simulate the capabilities of look-up intercepts, look-down intercepts, or radar missile attacks because the F-5E's radar is incompatible with more modern

long-range radars. For visual air combat maneuvers, the F-5E's turn rate is too high to simulate the MIG-23 and MIG-31. For the MIG-29 and SU-27, the F-5E's turn rate is too low. In addition, the F-5E is too small in size to visually simulate any of the Soviet fighters discussed.

This analysis of air combat tasks indicates that the present F-5E can only simulate 2 of 6 tasks for each of the new Soviet fighters. Although the infrared missile attacks and gun attacks can be simulated by the present F-5E, the lack of intercept and air combat maneuver simulation limits its usefulness even as a "part-task" simulator.

ANALYSIS OF WHICH AIR COMBAT TASKS UPGRADED F-5E CAN SIMULATE

The results of the upgraded F-5E's capability to simulate the new Soviet fighters is depicted in Table 18. The upgraded F-5E can simulate 5 of 6 tasks for the MIG-23. No improvement was shown for the upgraded F-5E to simulate the MIG-31, MIG-29, or SU-27 air combat task capabilities; the total is still 2 of 6 for each aircraft.

The improved radar of the upgraded F-5E was rated a shortfall in the upgraded F-5E and MIG-23 comparison of Chapter IV. This shortfall was based upon the much shorter track range of the upgraded F-5E versus the MIG-23, 10 NM and 29 NM, respectively. Although this is a significant

TABLE 17. ANALYSIS OF WHICH AIR COMBAT TASKS F-5E CAN SIMULATE

TASK \ AIRCRAFT	MIG-23	MIG-31	MIG-29	SU-27
LOOK-UP INTERCEPTS	NO	NO	NO	NO
LOOK-DOWN INTERCEPTS	NO	NO	NO	NO
VISUAL AIR COMBAT MANEUVERS	NO	NO	NO	NO
RADAR MISSILE ATTACKS	NO	NO	NO	NO
INFRARED MISSILE ATTACKS	YES	YES	YES	YES
GUN ATTACKS	YES	YES	YES	YES
TOTAL OF TASKS F-5E CAN SIMULATE	2/6	2/6	2/6	2/6

LEGEND: YES (F-5E can simulate this task for this aircraft)

NO (F-5E cannot simulate this task for this aircraft)

TABLE 18. ANALYSIS OF WHICH AIR COMBAT TASKS UPGRADED F-5E CAN SIMULATE

TASK \ AIRCRAFT	MIG-23	MIG-31	MIG-29	SU-27
LOOK-UP INTERCEPTS	YES	NO	NO	NO
LOOK-DOWN INTERCEPTS	YES	NO	NO	NO
VISUAL AIR COMBAT MANEUVERS	NO	NO	NO	NO
RADAR MISSILE ATTACKS	YES	NO	NO	NO
INFRARED MISSILE ATTACKS	YES	YES	YES	YES
GUN ATTACKS	YES	YES	YES	YES
TOTAL OF TASKS F-5E CAN SIMULATE	5/6	2/6	2/6	2/6

LEGEND: YES (F-5E can simulate this task for this aircraft)

NO (F-5E cannot simulate this task for this aircraft)

difference, the search range and angle-track capabilities of the upgraded F-5E are adequate to simulate the MIG-23's look-up and look-down intercept capabilities. Even though the upgraded F-5E cannot track a target as distant as the MIG-23, it can simulate a radar-homing missile launch inside 10 nautical miles. This range is half the 20 NM maximum aerodynamic launch range of the Soviet AA-7 Apex radar-homing missile against a head-on target but is compatible with the more likely launch range of this missile.[2] Air-to-air missiles are rarely launched at their maximum aerodynamic range because, if the target maneuvers at all after missile launch, the probability of a kill is very low. Therefore, the upgraded F-5E can simulate MIG-23 radar missile attacks. The capability to simulate infrared missile and gun attacks is unchanged from the present F-5E analysis.

The upgraded F-5E cannot simulate the MIG-23 visual air combat maneuver task. The upgraded F-5E's turn rate is still too high and its size is too small. This analysis of air combat tasks indicates that the upgraded F-5E can serve as an acceptable part-task simulator for the MIG-23. Part-task simulator means that the F-5E can simulate MIG-23 intercept tactics and weapons employment tasks but not MIG-23 visual air combat maneuvering tasks.

The MIG-31, MIG-29, and SU-27 have long-range, pulse Doppler, track-while-scan radars. The upgraded F-5E has a relatively short-range, pulse, single-target-track radar that

is incapable of simulating the look-up and look-down intercepts or advanced medium-range radar-homing and active guidance missile attack capabilities of these aircraft. Since the upgraded F-5E did not change in size or turn rate, it remains unable to simulate the visual air combat maneuvering capability of these three aircraft.

Although the upgraded F-5E can simulate infrared missile and gun attacks for the Foxhound, Fulcrum, and Flanker, the inability to simulate intercept tactics and air combat maneuvering for these aircraft limits its usefulness as a part-task simulator.

ENDNOTES

[1] Dunn, L. R. "Can Air Combat Training Be Realistic." Speech before 1978 Air University Airpower Symposium, Maxwell AFB, Alabama, February 1978, p. 4.

[2] Taylor, J. W. R., Editor. "Gallery of Soviet Aerospace Weapons," Air Force Magazine, March 1984, p. 126.

CHAPTER VI

CONCLUSIONS, RECOMMENDATIONS FOR FUTURE STUDY, AND SUMMARY

CONCLUSIONS

The F-5E was compared against the MIG-21 to establish a standard of acceptability for aircraft simulation. This comparison of ten selected characteristics and capabilities showed that the F-5E and MIG-21 are in fact very similar. Next, the F-5E was compared against the MIG-23, MIG-31, MIG-29, and SU-27 to determine if the F-5E possessed shortfalls in simulating the characteristics and capabilities of these new Soviet fighters. Based upon these comparisons, the F-5E was determined to possess shortfalls for the following number of categories per aircraft: MIG-23, 8 of 10; MIG-31, 8 of 10; MIG-29, 9 of 10; and SU-27, 9 of 10.

When the upgraded F-5E was compared against these aircraft, the number of F-5E shortfalls remained the same for all aircraft except the MIG-23. The upgraded F-5E's shortfalls in simulating the MIG-23 were reduced to 5 of 10. This improvement was due to the increased radar capability of the upgraded F-5E.

When the F-5E was compared against the six air combat tasks performed by the new Soviet fighters, the F-5E was

capable of simulating only 2 of 6 tasks for each aircraft. These two tasks were common to all aircraft and were infrared missile and gun attacks.

When the upgraded F-5E was compared against training tasks, it showed improvement again for only the MIG-23. The upgraded F-5E could simulate 5 of 6 tasks for the MIG-23. This improvement was also attributed to the increased radar capability of the upgraded F-5E.

This study concludes that the present F-5E is not a good simulator for any of the new Soviet aircraft discussed. The upgraded F-5E, however, can serve as a part-task simulator for the MIG-23. The tasks it can simulate for the MIG-23 are intercept tactics and weapons employment. It cannot simulate the visual air combat maneuvering of the MIG-23 Flogger.

RECOMMENDATIONS FOR FUTURE STUDY

This study focused on the current and future effectiveness of the F-5E's role in the Aggressor mission. Further studies should be undertaken to identify what aircraft(s) should replace the Aggressor F-5E's to provide the most realistic, dissimilar air combat tactics training for U.S. fighter aircrews. Studies should consider the new Soviet aircraft characteristics, capabilities, and air combat tasking discussed in this thesis.

Future studies should examine if the Aggressors should be expanded to have specialized squadrons flying different

aircraft; i.e., one squadron flying one type of aircraft simulating the MIG-21 and MIG-23, and another squadron flying another type of aircraft simulating the MIG-31, MIG-29, and SU-27.

Finally, future studies should address whether the Aggressors, flying more modern fighters, could also have an air combat readiness mission to utilize the Aggressor aircraft and pilot air superiority flying expertise.

SUMMARY

The Soviet Union has closed the technology gap on the United States in the air superiority fighter role. The Soviets have come a long way since the early 1960's simple and rudimentary aircraft designs. The new Soviet aircraft addressed in this study are extremely advanced when compared to the MIG-21.

If our aircrews are to be more prepared than they were in the Vietnam War, when the kill/loss ratio of the USAF was only 2:1, they must train against the most realistic adversary possible. USAF pilots flying the advanced F-15 and F-16 aircraft need to train against a realistic simulator of the MIG-23 or other new Soviet fighters. To adequately simulate the modern Soviet fighters and provide the appropriate DACT training, an aircraft must possess the radar, air combat maneuvering potential, and weapons simulation capability of the new Soviet aircraft. This realism is necessary to challenge

the F-15 and F-16 pilots to develop the winning tactics and fighting philosophy that could be employed in time of actual combat.

The USAF Aggressor squadrons have provided a credible, realistic threat training capability for U.S. fighter aircrews. The program itself is a tremendous improvement over the years of air combat training before 1972. To maintain credibility and usefulness in the mission of dissimilar air combat tactics training, the personnel and equipment of the Aggressors must keep pace with the adversary. Otherwise, the derived training could be more harmful than helpful.

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