STRATEGY RESEARCH PROJECT

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# THE POOR MAN'S AIR FORCE: IMPLICATIONS OF THE EVOLVING CRUISE MISSILE THREAT

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## ABSTRACT

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For several years, the United States has expended considerable resources on countering the theater ballistic missile threat. During this time, we have relatively ignored a growing land attack cruise missile threat. Land attack cruise missiles have the potential to be even more deadly than ballistic missiles, able to deliver similar payloads over similar distances with much greater accuracy. Advanced cruise missiles can penetrate existing air defenses, giving potential regional adversaries a significant ability to conduct strategic attack and interdiction against our military forces, a poor man's air force. Additionally, cruise missiles, synchronized with employment of ballistic missiles and manned aircraft, can have a synergistic effect. Efforts to prevent cruise missile proliferation have been ineffective, and highly lethal systems will likely be in the arsenals of many Third World nations within the next decade. Our nation needs to pursue theater air defense capability to detect, identify, track, engage, and destroy advanced cruise missiles to be prepared for this evolving threat.

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## INTRODUCTION

*The Arabian Gulf war of 2003 started off very much like the Desert Storm campaign. Iran, not content with seizing Iraqi lands south of Basra, had also occupied the rich oil fields of Kuwait. The fight with a drastically weakened Iraq merely settled an old score, but the move into Kuwait was a calculated response to two years of United Nations sanctions resulting from the Caspian Sea oil disputes. The U.S. reaction was predictable, forming a coalition of Gulf and European states and beginning a rapid troop buildup in Saudi Arabia. Significant air and naval forces had already deployed to the region, and land forces were arriving. The world press had already predicted a quick victory with the overwhelming technological advantage of America and her Western allies.*

*The newly formed Iranian War Council was determined not to make the same mistakes as Sadaam Hussein. The first small-scale attack against coalition forces occurred while American forces were offloading at Saudi ports. The vastly superior allied air force had repulsed the Iranian air attack without a single loss. The ballistic missile attack was only somewhat more successful because the majority of missiles were destroyed by land- and ship-based surface-to-air missiles; a tribute to the enormous US expenditure for theater missile defense systems. The missiles that reached their targets did relatively minor damage to port facilities and did not significantly slow the flow of forces.*

*The Americans were certainly pleased with the first battle, bolstering their predictions of decisive victory. However, the results were not unexpected by Iran. Considering their observations of Desert Storm, they generally viewed these as "use or lose" systems, weapons that would be quickly destroyed by early coalition airstrikes. They realized that*

*Western technology gave the coalition asymmetric advantages, and had planned for that eventuality for several years. They had sought ways to overcome their technological disadvantage, and felt they had the answer: massive cruise missile launches. Those weapons were now dispersed in preparation for the expected coalition air attack.*

"The nation is on track with the development of systems to counter most of the theater ballistic missile threat. Unfortunately, we are missing the mark on the cruise missile, the very short-range ballistic missile, and the reconnaissance/lethal unmanned aerial vehicle (UAV) threat." [1]

For several years, especially after our experience in Desert Storm, the United States has worked diligently at developing defenses against the ballistic missile threat, while maintaining our overwhelming superiority in manned aircraft capability. At the same time, we have been relatively oblivious to a growing cruise missile threat. A major reason we have not addressed the looming cruise missile threat is that political controversy in the US and in Western Europe over ballistic missile defense has fixated the analytical and political communities on the proliferation of ballistic missiles. [2]

Yet the cruise missile has the potential to be a more dangerous threat than ballistic missiles, providing Third World nations an avenue to develop air power capability not previously available within their resource constraints. This paper will examine implications of that growing threat by discussing the proliferation of cruise missiles, the features that make cruise missiles the growing weapon of choice in the Third World, Western defensive capabilities against the threat, and the effect that synchronized and synergistic use of cruise missiles can have on our air operations.

Merely defining a cruise missile is difficult. The 1987 US-Soviet Intermediate Nuclear Forces Treaty defined it as an "unmanned, self-propelled vehicle that sustains flight through the use aerodynamical lift over most of its flight path." It is commonly understood to be a relatively small, relatively cheap pilotless aircraft used to deliver a rather powerful warhead, more or less precisely, at a distant target. [3]

It generally comes in two varieties, the anti-ship cruise missile (ASCM) and the land attack cruise missile. Both can be launched from several platforms, including aircraft, ships, and ground vehicles. ASCMs have been widely deployed and employed for a number of years, but the proliferation of the land attack variety is a fairly recent phenomenon. It is this addition of these highly lethal, land attack cruise missiles to military inventories that provide potential regional adversaries the means to develop a "poor man's air force."

## HISTORY

Cruise missiles have been around for over 50 years. The first cruise missile used in combat was the German V-1 during World War Two. Powered by a pulsejet engine, it carried a 1,870 pound warhead at 375 mph and approximately 2,000 feet altitude for over 150 miles, at which point the engine shut off and the missile dropped into its target area.[4] Between June 1944 and March 1945, the Germans fired approximately 10,000 V-1s at London. Casualties included over 5,000 dead, 40,000 injured, and over 130,000 homes destroyed with more than 720,000 damaged.[5]

After World War Two, the United States attempted to develop a second generation land attack cruise missile. Efforts to field this nuclear-armed weapon system were

generally unsuccessful due to technical shortcomings in development of guidance systems. [6] During the 1950s and 1960s the Soviets developed a number of ASCMs to counter US aircraft carriers. The SS-N-2 Styx, fielded in 1956, was the first surface-to-surface ASCM, and the Soviets also fielded several air-to-surface cruise missiles for their bomber forces around this time frame. The Soviets exported several types of ASCMs, as evidenced by an Egyptian Styx sinking the Israeli destroyer *Eliat* in 1967. [7]

It wasn't until the 1970s that several technological advances allowed the US developed a third generation cruise missile. Microelectronics advances solved guidance problems and made possible terrain contour matching, while engine improvements and high energy fuels extended the ranges of cruise missiles. The US Air Force fielded the AGM-86B air launched cruise missile in 1982, while the US Navy developed a sea-launched version. The best known US system, the BGM-109 Tomahawk, entered service in the mid-1980s. Its two variants were the tactical anti-ship missile (TASM) and the Tomahawk land attack missile (TLAM) with conventional warhead, submunitions dispenser, or a nuclear armed warhead. [8]

In addition to the sinking of the *Eliat* in 1967, ASCMs were used successfully in the 1971 Indo-Pakistani war, the Yom Kippur war in 1973, and the 1980-1988 Iran-Iraq war. In 1988 an Iraqi Mirage fired two Exocet ASCMs at the USS *Stark*, killing 37 sailors and heavily damaging the frigate.[9] The most significant employment was during Falklands conflict in 1982. Argentina launched five Exocets, her entire inventory, scoring three hits. Air-launched Exocets hit and sank the destroyer HMS *Sheffield* and the container ship *Atlantic Conveyor*, and a ground-launched Exocet damaged the destroyer HMS *Glamorgan*. [10] In fact, those five Exocets fired in the Falklands conflict did more

damage than all the Scud missiles fired during Desert Storm.[11] Although ASCMs have been widely used since 1967, land attack cruise missiles were not used in combat between the V-1s in 1945 and the US Tomahawks launched in Desert Storm. [12]

## PROLIFERATION

"Land attack cruise missiles are a technology which, we expect, will proliferate and go into more countries." Secretary of Defense William Perry, 1994[13]

Cruise missiles have become fairly widespread throughout the military arsenals of the world. Over 70 countries currently possess cruise missiles, the majority of those being ASCMs. There are also at least 24 countries that have aerospace industries capable of producing cruise missiles and 15 countries that actually manufacture and sell cruise missiles. Of these numbers, at least 16 countries possess relatively large and diverse cruise missile arsenals. [14] And the number continues to grow.

Intelligence agencies estimate that over 40,000 cruise missiles will be in the inventories of over 100 countries by the year 2000,[15] and these numbers are not just ASCMs. Land attack cruise missiles are rapidly spreading throughout the world. In 1995, Lt Gen Malcolm O'Neill, Director of the Ballistic Missile Defense Office, testified to Congress:

> "Thirteen countries are developing land-attack cruise missiles. Iran is expected to deploy a system that is converted from a UAV by the year 2000. China is working on a system with moderate signature reduction that could be deployed about the same timeframe. Cruise missiles are marketed actively throughout the world, which indicates that very potent systems may reach the hands of potentially hostile countries." [16]

There are a number of reasons for this proliferation of land attack cruise missiles. Previously, longer range land attack cruise missiles required sophisticated guidance systems and significant support capabilities to produce terrain maps. This essentially limited these systems to the superpowers. Now, technologies and new products provide the missing link that allows many Third World nations to pursue their own land attack cruise missile arsenals. These include readily available navigation and imagery from commercial satellites and sophisticated mission planning tools. [17]

Proliferation is not limited to older or less-capable systems either. At the 1995 Paris Air Show and the 1994 Singapore Air Show, the French Apache stealth cruise missile was on display for export. At the 1993 Abu Dhabi Defense Exhibition, a shorter range version of the Russian AS-15 was on sale. [18] Iran already has Chinese Silkworm and Russian SS-N-22 supersonic cruise missiles along the Straits of Hormuz,[19] and is developing an improved Silkworm with a range of 450 km, enough to cover the entire Arabian Gulf and part of the Saudi peninsula.[20] The Chinese are expected to have stealthy cruise missiles for sale soon after the turn of the century.[21] A Defense Department report concluded that several countries, including Iran, will have cruise missiles with some degree of stealth technology between 2000 and 2010.[22]

Nor is the proliferation of cruise missiles the result of irresponsible actions by other nations. The US is the largest cruise missile exporter. We have supplied the Harpoon ASCM to 23 nations, including NATO allies, South America, the Far East and the Middle East, including Iran. The export of ASCMs such as the Harpoon is relevant to proliferation for several reasons. They are adaptable to a land attack role, but perhaps

more importantly they provide the technology to serve as a building block for potential adversaries' own cruise missile development efforts.[23]

## THE MISSILE TECHNOLOGY CONTROL REGIME AND CRUISE MISSILES

"The MTCR cannot stop the spread of cruise missiles: it can only slow the speed of their proliferation."[24]

The primary means for countering the proliferation of cruise missiles is the 1987 Missile Technology Control Regime (MTCR). This voluntary international agreement is primarily aimed at ballistic missiles, but also limits the export of some cruise missiles and their sub-systems.[25] The restrictions under MTCR are far less for cruise missiles than for ballistic missiles. This is for several reasons. For one, the MTCR intentionally avoids any restriction on manned aircraft sales. This allows potential proliferators to use aircraft purchases to gain the needed components and technology, yet still hide cruise missile development efforts. This, coupled with tremendous growth in computer technology, availability of digital mapping software, and inexpensive precision navigation capability, provides Third World nations with all the tools they need to produce highly effective missiles.[26]

Countries that have the capability to build military aircraft or remotely piloted vehicles (RPV) have the basis to develop a cruise missile production capability.[27] Currently, 91 nations operate aircraft, 45 of these have some form of indigenous aviation industry, 18 build aircraft under license, and 21 design their own aircraft.[28] In addition to Western nations, there are currently at least 11 Third World countries that have military aircraft production capability and 10 that can build RPVs.[29]

The MTCR applies its most restrictive provisions to cruise missiles that are capable of delivering a 500 kg warhead at least 300 km. However, there is a problem defining which systems are restricted, largely due to the very easy trade off between range and payload. Systems that are not restricted because their range is under the limit can easily be modified or their range extended with a lighter warhead. One example is the Apache. French officials claim this stealthy missile does not fall under MTCR restrictions. An adversary equipped with such an advanced cruise missile would prove difficult for Western air defense systems.[30]

## CRUISE MISSILES AS THE WEAPON OF CHOICE

"The problem of stopping large numbers of subsonic, ground-hugging, low-observable cruise missiles is considered more intractable, just as likely to occur and certainly less studied, than ballistic missile attack."[31]

Cruise missiles have a number of advantages over both ballistic missiles and manned aircraft as the weapon of choice of Third World nations. These advantages include cost, availability, accuracy, reliability, and survivability. Let's first examine the cruise missile against the ballistic missile.

Cruise missiles are less expensive to develop or purchase and require less support infrastructure to deploy. Cruise missiles can be readily placed in canisters, which makes them well suited to operate in harsh environments. Their exhaust plumes are generally not detectable by space-based sensors, and they require virtually no special launch stability, so they can be launched from almost any platform. Additionally, they fly a zigzag path to their target, so it is difficult for defenders to track them, determine their

intended target, or locate their launch site. They generally have an active guidance system, so they are much more accurate than ballistic missiles.[32]

Cruise missiles are becoming more effective and accessible because of the availability of small turbojet engines with increased reliability and fuel efficiency, improved and less-expensive seeker heads, and simple but accurate navigation through Global Positioning System (GPS) or the Russian GLONASS system. Cruise missiles are technologically less complicated than ballistic missiles.[33] They also can be much cheaper. The cruise missile can deliver a similar warhead size over a similar range more accurately and at 10 percent to 35 percent of the total cost of an equivalent ballistic missile.[34] A cruise missile based on an unmanned aerial vehicle could cost less than $100,000. A more advanced weapon, like the highly advanced Apache, might cost $1-2 million.[35]

Additionally, ballistic missiles are becoming less available, due largely to the effectiveness of the MTCR in this area. The former Soviet Union no longer supplies Scuds to client states, and Argentina, Brazil, South Africa, South Korea, and Iraq have halted ballistic missile production programs. Only North Korea still supplies MTCR-restricted ballistic missiles.[36]

Cruise missiles also have advantages over manned aircraft. Proponents of aircraft argue that they deliver munitions more accurately and more cheaply than cruise missiles. For a nation like the US this may be true, but Third World nations facing an opponent with a modern integrated air defense system (IADS) will find greater utility in cruise missiles.

Assume a nation possesses 100 modern attack aircraft worth $30 million each, and flies them two sorties a day with a ten percent combat attrition rate. By day four, over

half their aircraft have been destroyed, at a cost of $1.5 billion, not including significant costs such as pilots, training, and munitions. The greater utility of manned aircraft over cruise missiles assumes an extremely low attrition rate. Third World nations, facing modern IADS without the benefit of stealth aircraft, would likely absorb attrition rates high enough to make cruise missiles an attractive alternative. As a minimum, these countries should find a mix of land attack cruise missiles and manned aircraft very effective.

## CRUISE MISSILES AND WEAPONS OF MASS DESTRUCTION

*SFC Thompson's Avenger team certainly had drawn a great assignment. Defending Prince Sultan Air Base also meant sleeping in a real bed and eating at the Air Force dining hall. His team was on station about two miles north of the airfield when the platoon lieutenant passed him the word that all sectors were now at Air Raid Warning Red, and that the fighters that had launched before dawn were also returning to the base.*

*It was another half hour before he saw the cruise missile. It was not traveling very fast and was less than a mile east of their position, but his team was unable to react fast enough to get off a shot. He lost sight of the missile behind a sand dune, then saw it reemerge on the other side, heading directly towards the airfield.*

*The lieutenant acknowledged Thompson's report over the point defense radio net, realizing he had no assets to engage the leaker. He put down his headset and crossed the room looking for the Air Force colonel who was in charge of the Command Post, and thought about how he would break the bad news. Perhaps the missile would miss the*

*airfield altogether, or maybe it would just blow up a pile of worthless sand. The lieutenant never passed his report to the colonel.*

*The warhead detonated about a quarter mile from the middle of the airfield at about 500 feet above ground level. SFC Thompson was temporarily blinded by the flash, for although a ten kiloton yield is not large, he was looking right at the airfield. It would take weeks to put together an accurate casualty list, but if the Iranian War Council was right, two early casualties would be the cohesiveness of US-led coalition and the willingness of the American people to lose their sons and daughters in a war that was not theirs.*

Cruise missiles are ideally suited to deliver weapons of mass destruction. Their slow speed and high accuracy allow them to dispense chemical and biological agents either through submunitions or spraying. Cruise missiles are also effective delivery vehicles of nuclear warheads. Using the MTCR threshold of 500kg, there are at least ten cruise missiles that can deliver nuclear weapons.[37]

There is an alarming correlation between countries pursuing cruise missiles and those possessing weapons of mass destruction (WMD), nuclear, chemical, or biological capabilities. In addition to the US, UK, France, China, and Russia, there are at least eleven Third World nations that have the capability to deploy land attack cruise missiles and the capability to produce WMD. Additionally, eight other countries with WMD have ASCM capability.[38]

## CRUISE MISSILE DEFENSE SYSTEMS

*Lt Cdr Sam "Skittles" Hodges had been on station about 40 minutes, assigned to perform defensive counter air combat air patrol, or DCA CAP as it was listed in the air tasking order. He certainly would rather have taken his F/A-18 as part of the Roosevelt's strike package against the surface-to-air missile sites near Bandar Abbas. Perhaps tomorrow he would get an offensive mission. Another 20 minutes and he and his wingman were scheduled to go to the tanker, then another hour on CAP. The AWACS controller interrupted his thoughts.*

*"Snake 01 flight, vector 0-7-0, kill, single target 0-8-0, 29 miles, low." Skittles acknowledged the pairing, rolled out headed 0-7-0, and headed down to 10,000 feet above the Arabian Gulf. His wingman deployed to a right echelon position, spread one mile just as they had briefed back in the ready room. The radio crackled "target estimated 0-8-0, 15 miles, mach point seven, low, probable cruise missile." Skittles clicked his mic button in acknowledgment.*

*The F/A-18 radar detected the target at ten miles and under 1,000 feet altitude. Skittles continued his descent, offset right, and converted to the cruise missile's stern. Half way through the turn he had a brief visual contact with the missile, but lost sight as the missile's color blended well with the water and haze below. Skittles had planned to engage with an AIM-9M Sidewinder missile, but the cruise missile's small engine combined with a diffused, downward-angled exhaust did not put out sufficient heat source for the seeker head of the missile to track it over the relatively warm gulf waters. Skittles broke off right to achieve separation, then turned back to the target. As he came*

*out of the turn he got another radar lock and pulled the trigger. The AIM-120 Advanced Medium Range Air-Air Missile (AMRAAM) tracked to its target, and both Skittles and his wingman observed the cruise missile break into three pieces as a result of the AMRAAM's detonation. Skittles passed the results, "Fox one, splash one cruise missile, off south with 40 minutes playtime"*

*Lt Cdr Hodges wondered what the cruise missile's intended target was, but he did not reflect for long. The AWACS controller interrupted, "Snake 01 flight, kill, multiple targets, northeast, 30 miles, low, probable additional cruise missiles."*

"Negating the cruise missile threat will likely prove much more difficult than thwarting (theater ballistic missiles) TBMs. Cruise missiles in the short term will be dealt with similar to enemy aircraft, using airborne interceptors with look-down, shoot-down radars as well as ground defense systems. In the long term, stopping cruise missiles will require a new generation of passive infrared and active radar detection equipment."[39]

The wide use of ASCMs since 1967 have caused most Western navies, including the US, to develop and deploy effective ASCM defenses.[40] But land attack cruise missiles were last used against Western nations in 1945. It is easy to see why emphasis on cruise missile defense would be allowed to whither. Now with a potentially growing threat at the same time as defense budgets in Western nations are shrinking, we are faced with difficult decisions concerning which programs would be sacrificed to fund cruise missile defense improvements. Dependence on arms control measures alone is counterproductive. If we fail to also develop and deploy effective cruise missile defense systems, the proliferators are merely encouraged to pursue offensive capabilities faster and in greater numbers. And it is already clear the MTCR is ineffective in preventing cruise missile proliferation.

Efforts are required in three major areas: improved air-to-air missiles and fire control radars, surface-to-air missile systems, and wide area surveillance systems to detect, identify, track incoming missiles, and cue shooters. For the near term, planners expect that fighters are the best defense against the threat. The US Air Force is exploring a new version of the AMRAAM with a multispectral sensor that searches for infrared and radio signatures of cruise missiles.[41]

Improvements in surface-to-air missile systems are also on the horizon. The first upgrade to our current air defense capability is the Patriot Advanced Capability Level 3 (PAC-3). But PAC-3 was designed to counter high flying ballistic missiles, and will probably have questionable performance against low flying cruise missiles with small radar cross sections.[42] Theater High Altitude Area Air Defense (THAAD) is also designed primarily to counter ballistic missiles. The Medium Extended Area Defense System (MEADS) is being developed cooperatively by the US, France, Germany, and Italy.[43]

MEADS is unique in that it is being designed specifically to have capability against cruise missiles and unmanned aerial vehicles. It is expected to have a significant capability to defend against stealthy air vehicles. However it's ground based radar is a liability because of line of sight limitations to its range. Such restrictions would give it little more than self defense capability. Two options are being examined to overcome this shortfall. One is a helicopter-mounted radar system that would be expected to increase detection ranges against stealthy cruise missiles to 75-100 miles. The second option is an aerostat-mounted radar that, because of its ability to lift heavier payloads, could extend the detect range out to possibly 300 miles.[44]

In fact, Pentagon analysts have been examining the possibility of using aerostats to deploy a combination of radar and other sensors to detect and track of stealthy aircraft and missiles in high clutter environments. An airborne radar system, combined with other sensors, could possibly look down and even detect a moving empty spot created by a nonradar-reflective object. Operating costs of an aerostat-based system would be projected to be around $500 per hour, compared nearly $3,000 for an E-2 and $8,000 for an E-3 AWACS.[45]

Modifications to AWACS may also allow it to detect cruise missiles, combining improved radar with an anticipated infrared sensor upgrade. However, most specialists feel there is no single system that can solve the cruise missile problem and that hurdles exist in fusing information in a timely manner to allow cruise missile engagement.[46] One proposal presented by the editor of Aviation Week and Space Technology urges that the Air Force provide the surveillance portion of the solution while the Army and Navy provide the weaponry, such as Aegis and MEADS. In addressing the sensor requirement, the editorial contends "that combining special-frequency airborne radar with infrared and electro-optical sensors on board existing aircraft would produce the 'extended eyes' capability at a fraction of the cost." This division of labor saves money by allowing Army and Navy to cut sensor costs, and frees Air Force fighters for other tactical missions.[47]

In 1993, Secretary of Defense Dick Cheney said, "The size and flight profile of cruise missiles can stress the capabilities of air defenses."[48] What is clear is that defending against the next generation of highly accurate, low observable cruise missiles will be many times more difficult. Our current sensors are incapable of adequately detecting and

tracking these weapons, and research and development efforts that would lead to improved defensive weapons systems must compete for shrinking funds with the well established and high profile ballistic missile defense programs. With potential adversaries capable of fielding stealthy cruise missiles early in the next decade, time is running out.

## EFFECT ON AIR OPERATIONS

*Hauptmann Meier's Tornado was low on fuel as it crossed the northern Iranian coastline and went feet wet. Scrambled on an extreme priority mission to search and destroy temporary cruise missile storage facilities near Isfahan, he had become separated from the rest of his four-ship when the German Air Force strike package encountered heavier than expected anti-aircraft fire and then bad weather in the target area. More time for mission planning might have prevented this, but after the shocking Iranian attack at Prince Sultan, his mission took on new importance. Now flying single ship, he followed the minimum risk route over the gulf, decreasing his speed to 300 knots to conserve fuel.*

*Approaching the Saudi coastline he turned south and climbed to 15,000 feet, hoping to save a little more fuel. He considered diverting to Al Jubayl. As he followed the coastline, his radar warning receiver, which had been active throughout the mission, now displayed indications of an active Patriot radar. Hauptmann Meier was quite familiar with Patriot, his own German Air Force used the system, and he knew missiles were deployed all along the coast, a sort of Maginot air defense line. However, he was very surprised when his radar warning receiver displayed lock-on and launch indications. No*

*sooner had he rolled his Tornado to the right than he saw the missile streaking towards his jet. Instinctively, he broke hard left and dove for the deck. His futile efforts ended seconds later as the Patriot ripped his Tornado apart. Hauptmann Meier never had a chance to eject.*

*The Iranian plan to launch cruise missiles immediately after coalition air attacks was intended to serve two purposes. The Iranian planners thought that such timing might increase confusion, allowing a higher number of missiles to penetrate defenses and hit their targets at a critical time as the fighters and bombers were landing and defenses most vulnerable. The seven coalition aircraft shot down that morning by their own air defenses were a welcome bonus. The 230 cruise missiles wreaked havoc on efforts to identify friend from foe, and in the resulting confusion American fighters and land- and ship-based surface-to-air missiles destroyed two Saudi, three French, one Czech, and one German aircraft. Hauptmann Meier had survived his mission over Iran, only to be killed by friendly IADS.*

"We thought from the beginning that we would have to attack Scuds. What surprised us was that we put three times the effort that we thought we would on this job." Air Force Chief of Staff Merrill McPeak[49]

Military operations by the US in the past 50 years have been conducted relatively free from enemy air attack. This has provided tremendous freedom of action and allowed us to dictate the pace of operations. An adversary's ability to conduct offensive air operations against us would limit that freedom. Two examples demonstrate the effect that an enemy's offensive air operations have on the planning and conduct of our operations.

Operation Crossbow, from August 1943 to March 1945, was the allied effort to stop German V-1 and V-2 attacks during World War Two. All told, this effort consumed 68,913 sorties and dropped 122,133 tons of bombs. During the first 13 months of the operation, 15% of the bomber effort and 16% of the tactical fighter effort was diverted to defeating V-weapons. Despite this, missile launches continued until ground occupation finally stopped them.[50] It is estimated that the allies' effort to defend against the V-1 cost them four times the amount the Germans expended to conduct the offensive.[51] Modern cruise missiles fly at much lower altitudes, have a radar cross section 100 times smaller, and are two hundred times more accurate.[52]

Additional insight is gained by examining the effort expended in hunting Scuds during Desert Storm. Around 1,500 sorties were flown against known Scud targets, and at one point at least one-third of the 2,000 daily strategic attack sorties were diverted to Scud hunting duties.[53] On average, 6 percent of daily sorties were flown against the Scud threat.[54] All this was against a missile system that was considered militarily insignificant. It could deliver a single 2,000 pound warhead 300 km with a circular error probability of 900 meters.[55]

Although countering the missile threat in both World War Two and Desert Storm siphoned off a significant portion of airpower from other tasks, the other missions were still accomplished in both cases. The next war may not prove the same as Western air forces continue the drawdown. New generation cruise missiles provide potential adversaries the ability to attack us with precession throughout the theater of operations, and that attack may include WMD. The continuing political requirement, now combined

with a real military necessity to find and destroy both cruise and ballistic missiles, may drain off so much air power that other critical enemy capabilities are left untargeted.

Finally, our ability to perform combat identification of aircraft, especially in a coalition environment, has not been tested. Identification of our own aircraft using secure identification friend or foe (IFF) systems is fairly reliable, but future warfare will almost assuredly be a coalition undertaking, and allies' aircraft do not possess our IFF systems. This situation is compounded by our increasing reliance on UAVs and RPVs. This mix of manned and unmanned, US and allies, with well-timed enemy air attack including low observable cruise missiles, will be an IFF nightmare.

## SYNERGISM

*The Defense Support Program satellite orbiting 23,000 miles above the earth detected the infrared signature of three Iranian ballistic missiles. The data was downlinked to the Joint Tactical Ground Station (JTAGS), processed by CENTCOM's theater missile defense cell, and rebroadcast almost simultaneously via a series of tactical data links to every air defense command and control system in the theater.*

*Within the Air Operations Center, the Senior Air Defense Officer saw the launch indications, followed shortly by three trajectories and predicted impact points. Just as he had rehearsed in many exercises, he declared missile warning for the affected sector, and ordered the engagement of the inbound missiles.*

*The Patriot battery commander had closely followed the proceedings over her data link display, and knew her unit would be in the best position to engage. Her battery had sat for days in EMCON silent to conceal their whereabouts from the enemy, and now*

*would finally to get a chance to show their stuff. As soon as the pairing lines showed on her display, she ordered her radar out of standby, and searched the sky for the first target. The new PAC-3 missile would soon leap skyward to destroy the inbound Scud. Everything worked like a well-oiled machine.*

*Twenty miles away, other events were taking place that would disrupt that machinery. The small propeller-driven drone had loitered unobserved off the coast for nearly an hour. Now the anti-radiation missile seeker detected the Patriot tracking and acquisition radar signal. The small harassment drone made a beeline for the radar, barely exceeding 80 knots airspeed, well below the moving target threshold of the AWACS at 29,000 feet and 50 miles west of the tiny drone. Although two Patriot missiles would be successfully fired before the drone would crash into the fire control radar, the Iranians had achieved another cruise missile success. A seventy mile wide hole was punched in the coalition's integrated air defense system, and the remaining Iranian Air Force attack aircraft were just getting airborne.*

Low observable Tomahawk cruise missiles "made possible direct strikes at the heart of the Iraqi air defense system at the very outset of the war...the Coalition could strike Iraqi air defenses immediately and they never recovered from these initial, stunning blows."[56]

Each air attack system; manned aircraft, ballistic missiles, and cruise missiles, have inherent strengths and weaknesses. A savvy potential adversary will seek to achieve an appropriate balance of the three. Cruise missiles by themselves provide a Third World adversary the ability to strike a modern enemy, like the US, in a regional conflict. But the greater utility is in employing them to be complementary to other systems. We have provided the lesson to the world.

Our use of cruise missiles in initial strikes to disable Iraq's IADS enabled manned aircraft to deliver large quantities of munitions with virtual impunity. A Third World country can achieve similar results, albeit on a smaller scale. Advanced cruise missiles can serve as the enabling tool for operations by manned aircraft and ballistic missiles that would otherwise fall victim to our modern IADS. Carefully synchronized employment of all three types of weapons has the potential to multiply their effectiveness by achieving a high degree of synergism.

## CONCLUSIONS

"Today's widespread proliferation of ballistic and cruise missiles has perhaps redefined the notion of 'command of the air' espoused over a half century ago by Giulio Douhet. The possibility now exists that a nation can obtain air control without possessing an air force."[57]

There is a very real prospect that cruise missiles may soon be the "poor man's air force." This should come as no surprise. We have espoused our belief that even if air power cannot win wars by itself, wars cannot be won without it. The ability to control the air at the time and place of one's choosing and the ability to hold your enemy's strategic targets at risk is essential to modern warfighting. We have developed the most powerful air force in the world to ensure we have this capability.

Our actions certainly have not gone unnoticed by potential Third World adversaries. With no hope of matching our technology or resources to develop a manned air force, many turned to ballistic missiles as an alternative. We have reacted decisively to that threat by investing heavily in theater ballistic missile defenses and aggressively fighting

ballistic missile proliferation. These actions have driven our competitors toward the next alternative, procurement of modern cruise missiles.

Efforts to thwart this proliferation have been generally ineffective, and the outlook for future nonproliferation efforts is not encouraging. Additionally, our current defenses are not prepared to counter an advanced cruise missile threat. This is particularly dangerous because shrinking defense budgets are forcing difficult decisions in research and development efforts and weapons procurement. The ballistic missile threat has received such a great level of attention that it has overshadowed the evolving cruise missile threat.

The implications are clear. Advanced cruise missiles may soon be commonplace in the inventories of potential adversaries. We must pursue cruise missile defense with a new vigor, likely at the expense of some ballistic missile defense initiatives. The ability to detect, identify, track, engage, and destroy advanced, low-observable cruise missiles is an absolute necessity. Failure to do so will make the regional conflict of the next decade unacceptably dangerous.

## ENDNOTES

[1] Lt Gen Jay M. Garner, Letter to the Editor, Comparative Strategy 13, no. 5 (October - December 1994): 459

[2] Humphrey C. Ewing and Robin Ranger, Cruise Missiles: Precision and Countermeasures (Lancaster U.K.: Center for Defence and International Security Studies, 1995), 20

[3] Ibid., 7.

[4] Ibid., 15.

[5] Robin Ranger, "Theater Missile Defenses: Lessons from British Experiences with Air and Missiles Defenses," Comparative Strategy 12, no. 4, 405

[6] Ranger, Robin, "Cruise Missiles: New Threats, New Thinking," Comparative Strategy, 14, no. 3, July 1995, .259

[7] Ibid.

[8] Ibid., 260

[9] Ibid., 259

[10] Ibid.

[11] "Integrate Anti-Cruise Missile Planning," Aviation Week and Space Technology , (12 July 1993): 68.

[12] Ranger, 257

[13] Quote from William Perry, United States Secretary of Defense, February 1994, in Ewing, 5.

[14] Ewing, 9.

[15] Harry W. Jenkins, "Theater Ballistic Missile Defense: The Enabler for Operational Maneuver from the Sea for the 21st Century," Marine Corps Gazette 79, no. 7 (July 1995): 27.

[16] Ranger, 271

[17] Dennis M. Gormley and K. Scott McMahon, "Proliferation of Land-Attack Cruise Missiles: Prospects and Policy Implications," in Fighting Proliferation: New Concerns for the Nineties. ed. Henry Sokolski ( Maxwell Air Force Base: Air University Press, 1996), 135.

[18] Ibid., 136.

[19] "Integrate Anti-Cruise Missile Planning," 68.

[20] Ranger, 263

[21] "Integrate Anti-Cruise Missile Planning," 68.

[22] "Cruise Missiles Becoming Top Proliferation Threat," Aviation Week and Space Technology , (1 February 1993), 26.

[23] Gormley, 135.

[24] W. Seth Carus, Cruise Missile Proliferation in the 1990s, (Washington: Center for Strategic and International Studies, 1992), 92.

[25] Ewing, 22.

[26] Dennis Gormley, "Cruise Missile Threat Quietly Rises," Defense News, (27 March-2 pril 1995), 28.

[27] Ranger, 262.

[28]Federation of American Scientisits, "Cruise Missiles: The Other Air Breathing Threat." <http://www.fas.org/spp/aircrat/part05.htm>. 29 Jan 1997, 13.

[29] Ranger, 262.

[30] Gormley, 28.

[31] Fulgham, David A., "U.S. Developing Plan to Down Cruise Missiles." Aviation Week and Space Techology, (22 March 1993): 46, statement attributed to senior defense official.

[32] Ewing, 8.

[33] Fulgham, David A., "Cheap Cruise Missiles a Potent New Threat." Aviation Week and Space Technology, (6 September 1993): 54.

[34] Ranger, 256.

[35] Fulgham, 54.

[36] Gormley, 27.

[37] Federation of American Scientisits, 6.

[38] Ranger, 264-265, extracted from chart, does not imply these weapons are currently able to be delivered via cruise missile, but may be capability nations pursue.

[39] William C. Story, Third World Traps and Pitfalls: Ballistic Missiles, Cruise Missiles, and Land-Based Airpower (Maxwell Air Force Base: Air University Press, 1995.), 44.

[40] Ranger, 257.

[41] Fulgham, David A., "AMRAAM Sensor Mods Pace Missile Defense," Aviation Week and Space Technology, (29 April 1996), 59.

[42] Ewing, 18.

[43] Ibid.

[44] Fulgham, David A., "Helos, Aerostats to Push MEADS Range," Aviation Week and Space Technology, (30 October 1995), 53.

[45]Fulgham, David A., "Pentagon Sees Aerostats as Counter-Stealth Tool." Aviation Week and Space Technology, (13 February 1995), 56.

[46] Fulgham, "AMRAAM Sensor Mods Pace Missile Defense," 59.

[47] "Integrate Anti-Cruise Missile Planning," 68.

[48] Ewing, 17.

[49] Quote from Gen Merrill McPeak, Chief of Staff of the Air Force from Dr Keith B. Payne, "Defence Against Missile Proliferation," Jane's Intelligence Review 4, No. 5, (May 1992), 235.

[50] Story, 13.

[51] Stuart MacKenzie and Alan Stephens, Bolt from the Blue: The Ballistic and Cruise Missile Problem. (Fairbairn, Australia: Air Power Studies Center, 1994), 4.

[52] Ewing, 15.

[53] Story, 23.

[54] Ibid., 25.

[55] Ibid., 20.

[56] Ranger, 261. Taken from the *Gulf War Air Power Survey: Summary Report*, considered by many to be the authoritative analysis of the air war in Desert Storm.

[57] Story, 41.

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