

STAFF SUMMARY SHEET

	TO	ACTION	SIGNATURE (Surname), GRADE AND DATE		TO	ACTION	SIGNATURE (Surname), GRADE AND DATE
1	DFMI Dept Head	Approve	<i>[Signature]</i> LT COL, 12 Mar 13	6			
2	DFER	Review	<i>[Signature]</i> 17 Mar 13	7		<i>a few typos</i>	
3	DFMI	Action		8			
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SURNAME OF ACTION OFFICER AND GRADE Dr Talbot, AD-24	SYMBOL DFMI	PHONE 333-9425	TYPIST'S INITIALS bt	SUSPENSE DATE
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SUMMARY

1. **PURPOSE:** To provide security and policy review of the attached documents prior to public release.

2. **BACKGROUND:** Cadets Joshua Huckabee, Gordan Lang, Joseph Shields, Branden Shoenfeld, and Vincent Jovene were Military and Strategic Studies majors enrolled in our department's MSS 498 capstone course and their essays in this issue of Airman Scholar Journal represent their senior thesis work from Spring 2012. The final article is a book review by Cadet Edward Boylan, an MSS student in a senior core course. Note that the first article in this issue (Thomas Drohan, "Core Relevance at the Air Force Academy") was previously cleared for public release for a conference presentation in 2011.

Titles: 2) "Active Learning and the Rising Generation of Air Force Officers," 3) "Hands on Keyboard: Considerations for a Cyber Weapons School," 4) "Seizing the Ultimate High Ground: Weaponizing Space," 5) "An Airplane for all Seasons," 6) "Personnel Recovery: CV-22 Expansion Pack;" and 7) a book review of "War Made New."

Issue overview: Cadet Joshua Huckabee argues for improved simulation scenarios in the Cadet Battle Lab, DFMI's premier networked classroom. Cadet Gordan Lang follows with his proposal for a joint military cyber school to train the rising generation of cyber warriors. Cadet Joseph Shields argues the merits of weaponizing space. Cadet Brandon Shoenfeld argues that the Air Force should purchase the A-29 Super Tucano over the AT-6 Texan II built by a US-based company, and interestingly, the Air Force just announced the A-29 as it's choice, validating Brandon's argument. Cadet Vincent Jovene also make an airframe argument for Combat Search and Rescue, advocating the purchase of CV-22 Osprey's to augment the HH-50 rescue fleet. Lastly, our book review by Cadet Edward Boylan covers a primary text used in MSS 416, in which he was enrolled as a Humanities major.

Release Information: release for web-based publication in the e-journal entitled: Airman Scholar Journal (ASJ)

Recommended Distribution Statement: Distribution A, Approved for public release, distribution unlimited.

3. **RECOMMENDATION:** Sign Approve/Review blocks above indicating documents are suitable for public release. Suitability is based solely on the document being unclassified, not jeopardizing DOD interests, nor inaccurately portraying official policy.

[Signature]
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SEIZING THE ULTIMATE HIGH GROUND

WEAPONIZING SPACE

JOSEPH SHIELDS

Historically, humanity's greatest advancements in technology have been fueled by conflict. As Everett Dolman, a widely published scholar who has written multiple works discussing the benefits of weaponizing space, points

It was competition rather than cooperation that propelled mankind into space.

out in his book, *Astropolitik*, it was competition rather than cooperation that "propelled mankind into space."¹ During the Cold War, the United States and the Union of Soviet Socialist Republics (USSR) were pushed to explore space as an expression of intense, competitive nationalism. Although the USSR was the first nation to reach space, the US was able to recover from that initial setback and take the lead in space innovation, becoming the first to land a man on the moon. In other areas of development, particularly military technology, closing the gap may not be possible, particularly if those developments are used to deny access to certain aspects of the battlespace.

Since the end of the Cold War, innovations in space technology have become relatively stagnant. Although US reliance on space assets, both military and civilian,

has become irreversible and the quantity and quality of the technology in use has increased, their capabilities and applications have not seen much variation.² It would seem that another conflict might be necessary to inspire further developments. Despite undeniable American dominance in current space capabilities, declarations by Chinese officials of intent to weaponize space, coupled with hesitation by American policy makers to make such a momentous decision, could potentially put the US at a disadvantage in the event of another arms race.³ While many insist that the weaponization of space is not likely to happen soon, the development of new military technologies has been a fact of human existence. Realistically speaking, there is little room for an increase in land-, air- and sea-based capabilities. Even the development of robotic warfare serves only to enhance current capabilities by overcoming human frailties. This leaves the domains of space and cyberspace. Although cyber-attacks are becoming more common, kinetic modes of combat will always be necessary. This begs the question: when the time comes to take the ultimate high ground, how should the US go about weaponizing space?

Although space has been militarized for decades, there is no

public knowledge of any space-based weapon platform currently in existence. This is due, in part, to the general taboo placed on the pursuit of such capabilities by the global community and the generally stated belief that space should be reserved only for peaceful uses, to include homeland security.⁴ However, many countries, such as the US, and Russia, and China, are keeping open the option of weaponizing space. As stated above, China has already declared its intent to weaponize space and the only widely signed treaty banning weapons in space refers to nuclear weapons.⁵ While the treaty was being negotiated in the early 1960s, attempts to ban all weapons in space were stalled by the USSR.⁶ More recently in 2008, prior to China's aforementioned statement of intent to place weapons in space, the *New York Times* reported that Russia and China presented a proposal to the United Nations (UN) attempting to revive a blanket ban on such weapons, a proposal which the US immediately rejected.⁷ Because the US itself refuses to abandon this line of research on space-based weapons, the subject must be explored. To begin analyzing how space could be exploited, one must first look at current capabilities.

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The US military performs many kinetic combat and defense roles. Not all of these would benefit in a particularly meaningful way from space-based platforms. Close air support for example, while technically possible, is not practical from a space platform. Accordingly the scope of this paper will be limited to ballistic missile defense (BMD), integrated air defense (IAD), and power projection. In this case, "power projection" refers to the mission statement of the US Air Force to provide global reach capability. Currently, this mission is limited by enemy air defense capabilities, particularly in contested air space. Integrated air defense refers to the systems in place designed to deny access to enemy air assets. Ballistic missile defense is, in the nuclear age, one of the most important military missions. It provides a measure of

tance in US security. Currently, US BMD capabilities are more advanced than those of any other country, but they are by no means infallible.⁸

According to the Missile Defense Agency's website, the United States currently has four separate missile defense systems that can be employed at three different stages of an incoming ballistic missile's trajectory. Each of the three stages, Ascent, Midcourse, and Terminal, are approached in the same way. Early in its flight, the incoming missile is picked up and tracked by an advanced network of land-, sea-, and space-based detection platforms. A short time into its flight, the trajectory of the missile can be predicted and an intercept course can be programmed into the actuators of the Ballistic Missile Defense System (BMDS).⁹

(SM-3), as well as short-range ballistic missiles in the terminal phase with the SM-2."¹⁰ On its website, the Arms Control Association classifies short-, medium- and intermediate-range missiles as those that can collectively strike anywhere up to 5,500 kilometers away.¹¹ The Aegis BMD is also capable of tracking the longer range intercontinental ballistic missiles (ICBM) and coordinating that information with other interceptor systems.¹²

Ground-based Midcourse Defense (GMD) is the primary defense system of the North American continent. Bases in Alaska and California are capable of launching a kinetic energy interceptor, called the Exo-atmospheric Kill Vehicle (EKV), on a three-stage rocket designed to impact ICBMs and some intermediate-range ballistic missiles outside the Earth's atmosphere. The EKV is designed to destroy the target simply by striking it with adequate kinetic force.¹³

In the terminal defense segment, or final descent, of an incoming ballistic missile, the US has three BMD platforms. First, the Aegis BMD mentioned previously can attempt to intercept the missile once it reenters the atmosphere. The Terminal High Altitude Area Defense (THAAD) is a mobile BMD that can target the missile at higher altitudes both outside the atmosphere and upon reentry. Like the GMD, THAAD uses kinetic energy rather than a warhead to destroy the target. The third and final element is the PATRIOT Advanced Capability-3 (PAC-3). This platform is designed for both ballistic missile and air defense capabilities and is specifically intended to intercept missiles with a lower range, although it can



security and survivability that is not present in the mutually assured destruction (MAD) doctrine. The problem with MAD doctrine is that it is not an effective deterrent against non-state actors, and with increases in nuclear proliferation, BMD carries ever greater impor-

Currently, the first line of defense is the Aegis Ballistic Missile Defense System. The Aegis system employed by the Navy "defeats short- to intermediate-range, unitary and separating, midcourse-phase, ballistic missile threats with the Standard Missile-3

target ICBMs in their terminal or re-entry stage. The PAC-3 is employed by the US Army to compliment THAAD.¹⁴

The biggest issues with the US's current BMDs are time and gravity. Especially in the case of intermediate-range and ICBMs, these weapons are most vulnerable on their ascent when a large portion of their thrust is used to combat the effects of gravity. Once they begin their descent, ballistic missiles gain speed quickly as they close in on their target. Where this presents a problem is with long-range intercept methods. While the Aegis can be useful for shorter-range interceptions, the launch window against exo-atmospheric missiles is lamentably small before the more powerful ICBM will simply outrun the SM-3.

Long-range systems are limited by the same factors that make the ICBM vulnerable. There is a very limited window during which the GMD or THAAD must be launched in order to intercept the missile at the apex of its trajectory since both missiles must fight gravity on their way out of the atmosphere. If the first attempt to shoot down an incoming missile fails, then there will not be another opportunity to destroy the target before reentry into the atmosphere. After this point, the destruction of the target becomes not only more difficult but more risky. Gravity is now accelerating the missile while it slows the interceptors and destroying a ballistic missile in the atmosphere runs the risk of scattering whatever payload it might be carrying. This is especially hazardous in the case of biological and chemical weapons, where destruction of the target risks aerosolizing



Patriot or PAC 3 Launch

the payload wherever the wind takes it.

Although short- and medium-range ballistic missiles provide less time to be shot down, the geo-strategic location of the US means that any attack must come from an ICBM. If America's goal is to intercept these missiles before or during the exo-atmospheric stage, then preemptively placing a BMD network in orbit is the ideal solution. This way, the effort of fighting against gravity is already accomplished. When the ICBM is launched, the interceptors will already be waiting in orbit.

This space-based interceptor concept carries with it the potential for integration into the air defense system currently employed by the military. Current US air defense capabilities involve numerous early warning radar, ground-based missile defenses, and air-to-air weapons platforms. Ground- and air-based radar systems provide tracking capabilities of any detectable aircraft and relay this information to waiting air combat aircraft or surface-to-air missile sites.¹⁵ This IAD system works to deny aerial access to enemy forces. However, such systems are not unique to the US and those controlled by unfriendly nations are the greatest limiting factor on US

Air Force capabilities.

The "Vision" of the US Air Force is, "Global Vigilance, Reach, and Power."¹⁶ As the space domain has typically fallen under Air Force jurisdiction, it seems only fitting that the future of space development grow in accordance with that vision. Currently, US aircraft have the collective ability to strike anywhere in the world in a matter of hours. Ballistic missiles reduce this time to thirty minutes or less. Quick and devastating strikes are the key to success for any air force and such tactics were used to great effect against industrial targets early in the history of air power, with new technology dramatically increasing their effectiveness. Formidable as these capabilities might be, such power projection is limited by the similar capabilities of America's adversaries. For the power projection capability of the US Air Force to surmount these challenges and achieve its vision, new technology must be introduced.

Each of the aforementioned three missions—BMD, IAD, and power projection—can be achieved by space-based weapon systems. The RAND Corporation outlines, in one of their many publications on policy and strategy, entitled *Space Weapons Earth Wars*, four types of space-based weapons. These include directed-energy, kinetic-energy vs. missiles, kinetic-energy vs. surface targets, and conventional space-based weapons. Directed energy weapons include electronic jamming, laser cutting torches, and a variety of similar weapons. None of the directed energy weapons currently employed on a practical scale are

powerful enough to accomplish the kinetic missions listed above and will not be referenced in this paper. The latter three depend on the transfer of potential energy to destroy the target. Kinetic weapons rely on velocity and mass to cause damage, while the conventional

Rods from God [are] kinetic energy weapons capable of delivering destruction on the scale of nuclear weapons due to their enormous mass.

weapons that RAND refers to typically use stored chemical energy (i.e., explosives) to achieve their effect.¹⁷ Kinetic energy weapons have the advantage of being mechanically simpler, as well as cheaper, than conventional weapons with the disadvantage that they must be traveling at great speeds to achieve the same destructive capability. This works well with space-based systems because the high altitude means the projectile has a high potential energy, which translates directly to kinetic energy as the Earth's gravity accelerates it towards a chosen target. The basic physics involved is set forth in the following equation:

Potential Energy = gravitational acceleration x projectile mass x altitude

As applied to BMD, when the weapon system is launched, it is imbued with kinetic energy by the boosters which transfers to potential energy as its altitude increases. After that, it is a relatively simple matter of converting the potential energy of the system back into kinetic energy using gravity and intercepting the ICBM's course at the proper moment with a GPS

guidance system. In essence, this system will work much like the "Hypervelocity Rod Bundles"¹⁸ mentioned in the 2003 "US Air Force Transformation Flight Plan," a theoretical weapon system that, in many circles, has come to be known as the "Rods from God."

There has been much discussion across the internet on physics websites and future weapons blogs about the concept of these "Rods from God," kinetic energy weapons capable of delivering destruction on the scale of nuclear weapons due to their enormous mass. A recurring argument against this idea is noted on the Popular Science website: "Launching heavy... rods into space will require substantially cheaper rocket technology than we have today."¹⁹

While this is a legitimate concern for the powerful weapon system mentioned by the Air Force, the force of a nuclear weapon is far greater than the kinetic energy required to destroy any legal targets in a conflict, conventional or non-conventional. Although the cost of a space-based weapon system would be great, it would not be so prohibitively high as to prevent its implementation due to the far smaller weight of any useable weapon.²⁰

The greatest issue with this system is the problem of atmospheric reentry. The smallest and cheapest system would destroy ballistic missiles outside of the atmosphere where reentry would not be an issue. This limits the window of opportunity to the brief time when the target is above sixty kilometers.²¹

In order to engage below that altitude, larger projectiles with

atmospheric reentry capabilities would need to be built, greatly increasing the cost of the system. A reentry vehicle is required for such weapons, kinetic or conventional, intended for use against ground or aerial targets. The limitations of such kinetic weapons include the fact that, in order to maintain velocity, their maneuverability and target window is severely limited. In addition, because they derive their power from the pull of gravity, reentry angles must be steep, giving the weapon system a very narrow scope of targets at any given time. Because of this, a useful system would require deployment of a larger number of satellites to be in position to strike targets anywhere around the globe in a reasonable amount of time. According to RAND's study, six platforms in high orbit would only provide targeting opportunities every two to three hours.²²

These problems are addressed by RAND's fourth weapon type, conventional space-based weapons. Because these weapons rely on their explosive payload to do damage, they are less reliant on the pull of gravity and more maneuverable. This seems to suggest that, while kinetic weapons are limited to relatively slow-moving or stationary targets such as buildings or ships, these weapons could theoretically engage a wider range of targets, to include aircraft and missiles. This also results in a greater targeting window. The same number of space-based platforms requiring hours for kinetic systems to be in place could provide targeting opportunities within minutes using maneuverable weapons.²³

With any given weapon and type of mission, there are a few

security concerns that must be addressed when determining how to deploy these capabilities. The first step in establishing an undoubtedly unpopular space-based arsenal must be to ensure its security. Employment of space-based weapons would undermine long-standing treaties and unwritten agreements not to pursue an arms race or place ballistic missile defenses in space. Aside from the political backlash, certain countries will likely view this as an attempt to destabilize the

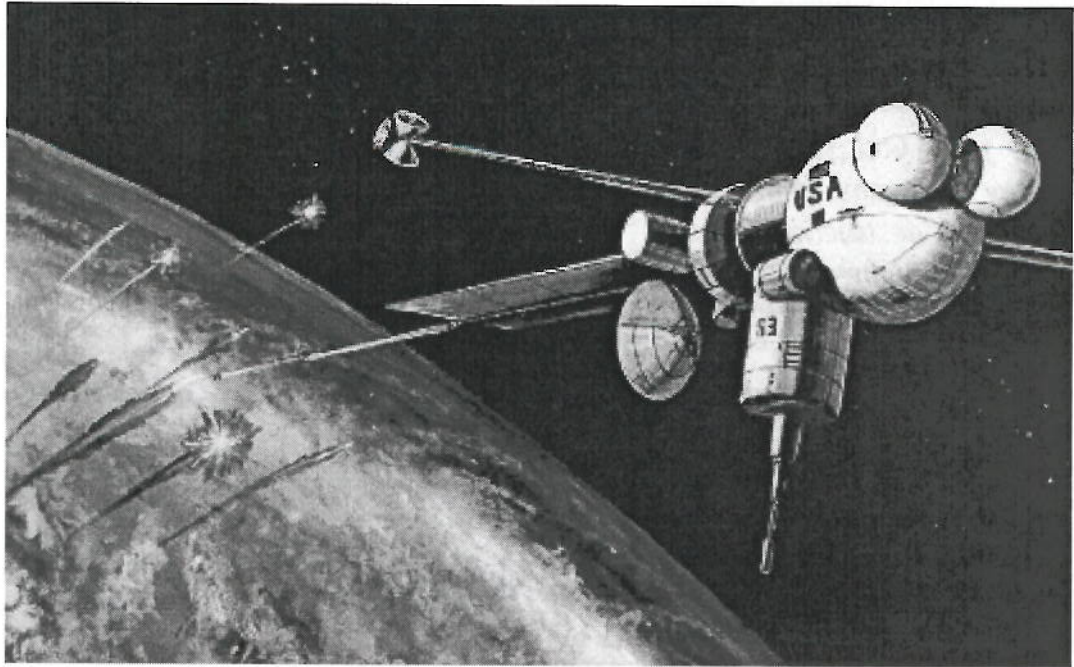
MAD doctrine that has thus far prevented nuclear war. Deterring the threat of a first strike attempt, then, should be the first step in establishing space superiority. This must be done quickly if it is to be effective because once the US plan becomes public knowledge; any military retaliation would have to engage before the system is in place to have a guaranteed effect.

The next concern is the demonstrated ability of other countries' anti-satellite (ASAT) weapons. Fortunately, such weapons operate on similar principles to ICBMs and must exit the atmosphere while operating against gravity. Once established, space BMD assets will be capable of destroying those threats before they have the chance to knock out a satellite. Non-BMD platforms, such as those designed for ground strike missions, must be within a certain proximity of such

a system to ensure survivability.

The third concern is the development of future technology by competing nations. Even if the US

such a system is the crucial step when any weaknesses in the net will be found and exploited and, should it fail, another opportunity will be less likely to present itself.



manages to establish its weapons in space before opposing nations can counter with their own developments, there is no doubt that the power gap created by such a capability will result in attempts to counter US space superiority. In other words, a space arms race is likely to ensue. In order to maintain the lead, the US must anticipate future adaptations to the new way of fighting. These potential adaptations could be combated through policy change, a shift in tactical focus, or any other means depending on the perceived threat, but the military must be flexible.

With these challenges in mind, it is imperative that the weaponization of space must start with an effective BMD satellite constellation. Decisions about this system cannot be influenced by anything other than effectiveness. The initial deployment of

While building a system that uses RAND's kinetic exo-atmospheric weapons to protect the US might seem desirable, it must be considered that a nuclear-capable nation with far less reliance on space assets than the US might detonate a nuclear device upon exiting the atmosphere, resulting in an electromagnetic shockwave that would knock out the new system along with every other satellite in the area. The kinetic destruction of a single Chinese satellite in 2007 in Low Earth Orbit (LEO) resulted in about 15,000 pieces of debris that are expected to threaten space assets for more than twenty years into the future.²⁴ The collateral damage resulting from a nuclear explosion in LEO would be far worse. As such, the initial BMD system must be capable of destroying targets before they exit the atmosphere.

In terms of the third concern listed above, there are many possible situations that may arise, not all of which will be covered. This paper will discuss briefly some of the opposing strategies

...given historical trends of realist politics along with technological and military dynamics, it is only a matter of time before weapons find their way into space.

that could prove problematic for the continued effectiveness of a space-based arsenal, although solutions to those problems are properly the subject for another paper. Assuming that the established BMD system is capable of defending itself from ground-based missiles, countries may look for other means to circumvent the defenses. Launching new "Trojan" satellites carrying ASAT weapons or self-destructive charges disguised as peaceful purpose satellites, or even redirecting existing satellites to collide with the weapon systems, are the biggest threats after the neutralization of ballistic missiles. The US will have to establish a policy regarding the launch of foreign satellites to prevent this, and/or establish countermeasures to prevent intentional collisions. Additionally, the potential to target surface capabilities may result, in the longer term, a shift in war-fighting strategies from surface to sub-surface warfare. Once initial attempts to counter a US space arsenal are exhausted, one could expect that there will be a shift toward short- to medium-range submarine-based nuclear missiles by US competitors/enemies, resulting in unknown launch points and

shorter flight times to complicate targeting by the space-based systems. Such counters might be viewed as an effort to correct the perceived disruption of the Cold War-era MAD doctrine.

There are many political concerns that are beyond the scope of this paper. However, given historical trends of realist politics along with technological and military dynamics, it is only a matter of time before weapons find their way into space, as Dolman advocates. The key for success in the future is to be the first nation to take that step. Although there will be inevitable political consequences, the US cannot allow itself to be placed at a major strategic disadvantage by its recent technological stagnation and an excessive concern with global opinion not shared by its rivals.²⁵

Although political backlash will be unavoidable, the deployment of US space-based weapons must be executed completely, resolutely, and swiftly. Though national security may temporarily be at greater risk during the deployment phase, once space-based defenses are in place, they will provide security for the global commons, much like the US Navy has provided on the high seas for decades, ensuring the safe movement of sea-based commerce, benefitting all, not just the US. A space-based system must first be defensively focused to demonstrate a US concern for global security and others must be assured that there are no aggressive intentions; control of global orbits will ensure that satellite commerce is safe from other would-be aggressors. Others aggressively-intended systems would be prevented from reaching orbit. Once the system

is in place, to include the establishment of an international body governing orbits and approving space-bound payloads, US national security policy and strategic focus will still need to accommodate the inevitable accompanying shifts in strategic warfare capabilities. In a world ruled by self-interest, the party that always plays nice will lose to the party that acts in its own self-interest. But in space, like the sea, US self-interest can serve mankind.

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6 Department of State, "Treaty on Principles Governing the Activities of States in the Exploration and use of Outer Space, Including the Moon and Other Celestial Bodies," <http://www.state.gov/www/global/arms/treaties/space1.html>

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17 Bob Preston, et al., *Space Weapons Earth Wars*, RAND Corporation, 2002, xvi, http://www.rand.org/content/dam/rand/pubs/monograph_reports/2011/RAND_MR1209.pdf

18 "US Air Force Transformation Flight Plan," US Air Force, November, 2003, 66, <http://www.au.af.mil/au/awc/>

awcgate/af/af_trans_flightplan_nov03.pdf

19 Eric Adams, "Rods from God," *Popular Science*, 1 June, 2004, <http://www.popsci.com/scitech/article/2004-06/rods-god>

20 RAND, xviii.

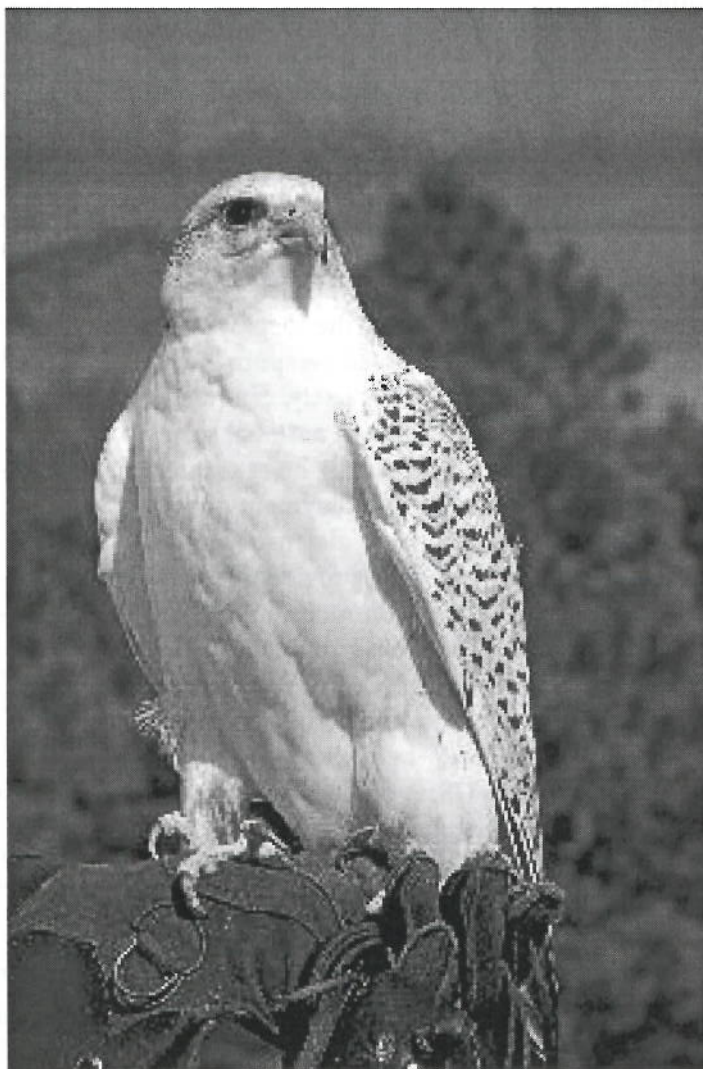
21 Ibid.

22 Ibid., xviii-xix.

23 Ibid.

24 Shirley Kan, "China's Anti-Satellite Weapon Test," CRS Report for Congress, 23 April, 2007, <http://www.fas.org/sgp/crs/row/RS22652.pdf>

25 Dolman, *Astropolitik*, 157.



Gyre Falcon,
Alias - "The Bird"