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14. ABSTRACT

This Master's research paper focuses on three case studies demonstrating how foreign nations illegally exported technologies, exploited capitalistic values, and used recruitment programs to access sensitive technologies and programs for their military gain. Furthermore, a lack of criminal prosecutions by the Department of Justice, combined with this exploitation, illustrates the loss of deterrence and critical technologies to our adversaries.

After acquiring U.S. companies, foreign nations illegally export technologies, often shutting down U.S. factories which results in losses to domestic production. Meanwhile, United States companies violate export restrictions by providing expertise on dual-use technologies when it is in their best interest. They may or may not report the assistance to the United States Government afterward. Further, the People's Republic of China uses recruitment programs, like 1,000 Grains of Sand and 1,000 Talents Plan, to gain access to sensitive technologies, research, and subject matter experts. Left unchanged, these vulnerabilities will continue to allow our adversaries to access sensitive military technologies, subject matter experts, and dual-use technologies, ultimately threatening the United States' technological advantage on the battlefield. This research examines three bodies of literature on how foreign nations acquire sensitive technologies from the United States. The first is the study of how, after the acquisition of the United States company, foreign owners illegally export technologies. The second examines how capitalistic values lead U.S. corporations to illegally provide expertise to foreign nations, violating U.S. export laws. The third body of literature focuses on how the People's Republic of China steals U.S. military technology through the 1,000 Grains of Sand and 1,000 Talents Plan. Alone, each of these is necessary but insufficient. However, together, they result in significant military gain for foreign militaries. This research focuses on older case studies for two reasons: first, the classified nature of recent illegal technology transfers and second, the abundance of information available as well as Congressional curiosity of these case studies.

The United States must re-evaluate its export rules and regulations, and its hesitance to prosecute those responsible for illegal technical transfers. This would involve many organizations within the U.S. Government, most notably the Department of Commerce, Department of Defense, Department of Justice, and the Department of State. The Department of Commerce and the Department of Justice currently fine companies responsible for illegal technological transfers, but settlements often allow companies to avoid Department of Justice prosecution for violations of the International Traffic in Arms Regulation. Further, these settlements do not revoke current export licenses or ban future export licenses for companies that have violated United States export regulations or otherwise participated in illegal technological transfers. Lastly, revoking visas of those illegally providing protected technical information to the People's Republic of China would impact recruitment program efforts, potentially disrupting attempts to gain sensitive information.

15. SUBJECT TERMS

Export laws; foreign acquisition of U.S. companies; export law violation; 1,000 Grains of Sand and 1,000 Talents Plan; Magnequench; Hughes Space and Communications; Terfenol-D

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MASTER OF MILITARY STUDIES

Capitalism's Double-Edged Sword:
How Foreign Nations and U.S. Corporations Circumvent Export
Rules and Regulations and the Dilemmas We Face to Make Change

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OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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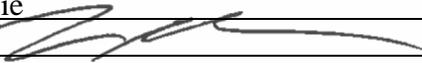
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Preface

My interest in researching how foreign nations, specifically China, gain access to United States critical technologies stems from my time as a Capabilities Integration Officer (Requirements Manager) at Headquarters Marine Corps Combat Development & Integration. During this time, I became involved in writing requirements, capability development, and defense acquisitions. While working at Combat Development & Integration, I attended National Intelligence University, where I extensively studied, researched, and wrote my thesis on the inherent vulnerabilities in an unclassified Department of Defense Acquisition System. The thesis, *Blatant theft: Foreign Nations and the Defense Acquisition System*, can be found in the National Intelligence University thesis archive on the Joint Worldwide Intelligence Communication System.

This masters research paper is an extension of *Blatant theft: Foreign Nations and the Defense Acquisition System*. This research builds upon the research within *Blatant theft: Foreign Nations and the Defense Acquisition System*, but shifts focus from the government to civilian industry. Whereas *Blatant theft: Foreign Nations and the Defense Acquisition System* focuses on identifying vulnerabilities within the three pillars of defense acquisition system: the joint capability integration development system (requirements); planning, programming, budgeting, and execution (funding); and procurement, this research exclusively focuses on vulnerabilities within civilian industry and how foreign nations acquire protected technologies. Taken together, it becomes clear how the United States loses critical protected techniques to our adversaries and that changes in national policy are required.

With renewed focus on acquiring “commercial off the shelf” capabilities, industry has become an important partner in developing military capabilities to implement the *Joint Warfighting Concept* and *Force Design 2030* successfully. As the United States military relies on more commercial off the shelf capabilities, the protection of these capabilities from inception to divestment has become increasingly important. Dual use technologies, which have both military and civilian applications, are increasing daily and require just as much protection as exclusively military technologies. If the United States continues to disregard the protection of critical technologies – whether government, military, or civilian – the United States military may one day find itself unable to maintain its technological advantage on the battlefield.

This research examines three case studies where technology was transferred from United State industry to the People’s Republic of China, and resulted in military gain for the People’s Liberation Army. Although this research focuses on older case studies, the methods examined are still used today by the People’s Republic of China to acquire military and civilian technologies. Further research within this area should focus on why policy changes within Department of Commerce, State, and Justice have not occurred; the barriers to effective policy change; and why the Department of Justice rarely, if ever, criminally prosecutes those responsible for illegal technological transfers.

Executive Summary

Title: Capitalism's Double-Edged Sword: How Foreign Nations and U.S. Corporations Circumvent Export Rules and Regulations and the Dilemmas We Face to Make Change

Author: Major Nicholle Miller, United States Marine Corps

Thesis: After acquiring United States companies, foreign nations illegally export technologies, exploit capitalistic values, and use recruitment programs to access sensitive technologies and programs for their military gain.

Discussion

This Master's research paper focuses on three case studies demonstrating how foreign nations illegally exported technologies, exploited capitalistic values, and used recruitment programs to access sensitive technologies and programs for their military gain. Furthermore, a lack of criminal prosecutions by the Department of Justice, combined with this exploitation, illustrates the loss of deterrence and critical technologies to our adversaries.

After acquiring U.S. companies, foreign nations illegally export technologies, often shutting down U.S. factories which results in losses to domestic production. Meanwhile, United States companies violate export restrictions by providing expertise on dual-use technologies when it is in their best interest. They may or may not report the assistance to the United States Government afterward. Further, the People's Republic of China uses recruitment programs, like *1,000 Grains of Sand* and *1,000 Talents Plan*, to gain access to sensitive technologies, research, and subject matter experts. Left unchanged, these vulnerabilities will continue to allow our adversaries to access sensitive military technologies, subject matter experts, and dual-use technologies, ultimately threatening the United States' technological advantage on the battlefield.

This research examines three bodies of literature on how foreign nations acquire sensitive technologies from the United States. The first is the study of how, after the acquisition of the United States company, foreign owners illegally export technologies. The second examines how capitalistic values lead U.S. corporations to illegally provide expertise to foreign nations, violating U.S. export laws. The third body of literature focuses on how the People's Republic of China steals U.S. military technology through the *1,000 Grains of Sand* and *1,000 Talents Plan*. Alone, each of these is necessary but insufficient. However, together, they result in significant military gain for foreign militaries. This research focuses on older case studies for two reasons: first, the classified nature of recent illegal technology transfers and second, the abundance of information available as well as Congressional curiosity of these case studies.

Conclusion

The United States must re-evaluate its export rules and regulations, and its hesitance to prosecute those responsible for illegal technical transfers. This would involve many organizations within the U.S. Government, most notably the Department of Commerce, Department of Defense, Department of Justice, and the Department of State. The Department of Commerce and the Department of Justice currently fine companies responsible for illegal technological transfers, but settlements often allow companies to avoid Department of Justice prosecution for violations of the International Traffic in Arms Regulation. Further, these settlements do not revoke current export licenses or ban future export licenses for companies that have violated United States export regulations or otherwise participated in illegal technological transfers. Lastly, revoking visas of those illegally providing protected technical information to the People's Republic of China would impact recruitment program efforts, potentially disrupting attempts to gain sensitive information.

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1. Innovation Under Siege: Introduction

Since the dawn of mankind, states and societies have worked to advance and modernize their capabilities and technologies. These capabilities and technologies span the range of improving everyday life to increasing lethality on the battlefield. These advances and modernizations can give a country a distinct advantage against adversaries, necessitating the classification of some technologies. Despite a nation's efforts to protect its capabilities and technologies, foreign nations illegally export technologies after acquiring United States companies, exploit capitalistic values, and use recruitment programs to access sensitive technologies and programs for their military gain.

This research aims to provide an understanding of the inherent vulnerabilities in corporate acquisitions, explore how capitalistic values threaten United States national security, and explain how foreign nations recruit and use everyday citizens to gain access to sensitive technologies. There is a long history of nations stealing capabilities, technologies, and subject matter expertise from each other. This has led to developing countermeasures, protection measures, and other security practices and policy implementations to protect investments, and critical and sensitive military technologies. As a result, foreign nations, specifically China, have expended significant resources to capitalize on vulnerabilities inherent within the United States' development of capabilities and sensitive technologies. The People's Republic of China uses these vulnerabilities to circumvent export restrictions and regulations to gain access to sensitive military technology, leading to 1) the exportation of controlled goods to restricted countries; 2) United States companies providing expertise on dual-use technologies; and 3) the use of recruitment programs, such as *1,000 Grains of Sands* and *1,000 Talents Plan*. The long-term consequences of allowing foreign nations to circumvent United States export restrictions and

relations could impact the Marine Corps' modernization efforts under *Force Design 2030*, the United States' military's ability to compete strategically, and the implementation of the *Joint Warfighting Concept 3.0*.

This research examines three bodies of literature on how the People's Republic of China acquires sensitive technologies from the United States. The first is the study of how, after the acquisition of the United States company, foreign owners illegally export technologies. The second examines how capitalistic values lead to United States corporations illegally providing expertise to foreign nations, violating United States export laws. The third body of literature focuses on how the People's Republic of China steals United States military technology through recruitment programs, such as *1,000 Grains of Sand* and *1,000 Talents Plan*. Alone, each of these is necessary but insufficient to achieve China's long-term goals. However, together, they result in significant military gain for the People's Liberation Army.

2. Literature Review

There are numerous studies, articles, intelligence reports, and other literature on the contributing factors surrounding foreign nations, both friends and adversaries, who illegally export technologies after acquiring United States companies, United States businesses providing expertise on dual-use technologies, and the use of students and subject matter experts to gain access to sensitive technologies and information. Still, the United States has not done enough to close vulnerabilities. Instead, the United States will publicly denounce some instances, ignore others, but not criminally prosecute. None of the research and literature examines how these actions impact the United States military advantage and challenge the status quo of continuing to do what has not worked. Left unchanged, these vulnerabilities will continue to allow our

adversaries to access sensitive military technologies, subject matter experts, and dual-use technologies, ultimately threatening the United States' technological advantage on the battlefield.

The first body of research explores how, after the acquisition of the United States companies, foreign owners illegally export technologies, undermine United States supply chains, and subvert United States technological advantages. The Department of Energy 2022's Response to Executive Order 14017, "American Supply Chains," *Rare Earth Permanent Magnets: Supply Chain Deep Dive Assessment*, evaluates the resiliency and security of the nation's critical supply chains and crafts strategies for the industrial base that underpins America's national security.¹ This report not only explores and outlines the raw material production, production, manufacturing, and use of the end-product magnets, it dives into the impacts of the production of critical technologies moving from the United States to foreign shores, like China.² Specifically, this report, in part, examines the impact of the Magnequench's acquisition and subsequent technology transfer to the People's Republic of China.

In his Washington Quarterly article, *Remember the Magnequench: An Objective Lesson in Globalization*, Charles Freeman III explains the Magnequench acquisition and discusses the impact of politics on the decision of the Committee on Foreign Investment in the United States to approve the acquisition and how the acquisition subsequently impacted competition between the United States and the People's Republic of China. Freedman also explores the impact of the Magnequench acquisition on manufacturing, the economy, global markets, what really matters, and why the Magnequench acquisition case study is important, almost twenty years later. The article provides a well-researched analysis of the impacts of the acquisition approval and its larger implication on globalization of trade and change.

The second body of research examines how capitalistic values lead to United States corporations illegally providing expertise to foreign nations, violating United States export laws. *China: Possible Missile Technology Transfers Under U.S. Satellite Export Policy – Actions and Chronology* is a Congressional Research Service Report for Congress written by a specialist in national security policy for the Foreign Affairs, Defense, and Trade Division. The author's name is redacted. *China: Possible Missile Technology Transfers Under U.S. Satellite Export Policy – Actions and Chronology* is a 2003 review on whether United States firms, in activities connected with exporting satellites, have provided expertise to China for use in its ballistic missile and space programs.³ Further, the report for Congress explores whether United States policy has facilitated transfers of military-related technology to China.⁴ The report draws no conclusions but is a well-research timeline of the actions and decisions Loral Space & Communications and Hughes Electronics took in 1996 before, during, and after the failed Intelsat 708 satellite launch on a Chinese Long March 3B rocket.

The *Report to the Select Committee of the United States House of Representatives from the Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China* is a declassified version of a classified final report. This three-volume, declassified version summarizes the findings and judgments contained in the classified report while providing a chronological timeline of the actions and decisions before and after the failed Intelsat 708 satellite launch. This report differs from *China: Possible Missile Technology Transfers Under U.S. Satellite Export Policy – Actions and Chronology* in that it draws conclusions about the classified reports, facts, and conclusions. Additionally, this report asserts the impacts of the thefts and Loral Space & Communications and Hughes Electronics' actions. Finally, and most importantly, this report does not focus solely on the failed Intelsat 708 satellite

launch. This report is a holistic review because it takes a broader approach to outlining how the People's Republic of China has also stolen other critical military technologies.

The National Security Dimensions of the Possible Acquisition of UNOCAL by CNOOC and Role of CFIUS is the testimony of the Honorable C. Richard D'Amato, the Chairman of the United States-China Economic and Security Review Commission. The testimony covers many of the national security issues raised by the possible Chinese acquisition of UNOCAL, a private energy company in the United States, by CNOOC, a state-owned oil company in the People's Republic of China.⁵ This testimony speaks to some of the events that led to and followed the Chinese acquisition of Magnequench.

The third body of literature focuses on how the People's Republic of China steals United States military technology through recruitment programs, such as *1,000 Grains of Sand* and *1,000 Talents Plan*. *The Staff Report on Threats to the U.S. Research Enterprise: China's Talent Recruitment Plans* is a 2019 report prepared for the United States Senate that dives into how American taxpayer-funded research has contributed to China's global rise over the last 20 years. The report details how the People's Republic of China openly recruits United States-based researchers, scientists, and public and private sector experts to provide them with knowledge and intellectual capital in exchange for monetary gain and other benefits.⁶ Further, the report details how the federal government's grant-making agencies, the Federal Bureau of Investigation, and other agencies did little to prevent this from happening.⁷

Leapfrogs and Shortcuts: Paths to Technological Performance on US and Chinese Strategic Evolutionary Landscapes is a Master's thesis by Major Rachel Reynolds, United States Air Force, that adapts a model of evolutionary biology to the problem of illegal technology transfer. In her research, Reynolds examines three cases of illegal technology transfers of

military critical technologies from 1980 through 2010. Specifically, she examines the transfer cost to China in terms of resources, skill, and risk.⁸ Finally, Reynolds assesses China's ability to attain the United States technology performance level; ultimately concluding China trades time and money for increased risk, but that no amount of risk enables China to achieve the same level of performance as the United States.⁹

Hunting the Phoenix: The Chinese Communist Party's Global Search for Technology and Talent provides an in-depth analysis by Alex Joske from the Australian Strategic Policy Institute on the People's Republic of China's use of talent-recruitment programs to gain technology from abroad through illegal or non-transparent means.¹⁰ Joske proposes that the response to the People's Republic of China's talent recruitment programs should be increased awareness and transparency of the programs, the Government-coordination of like-minded partners to study the talent recruitment activities, and security agencies investigating illegal behavior tied to foreign talent recruitment activity.¹¹ Finally, Joske proposes funding agencies require full disclosure of foreign talent-recruitment programs in grant applications and an audit by research institutions of staff participation in talent recruitment programs.¹²

Finally, there is substantial research about how foreign entities acquire United States technology to improve the capabilities of their military capability and what export control reforms should occur within the United States. The *Annual Report on the Military Power of the People's Republic of China* was a requirement of the National Defense Authorization Act of fiscal year 2000. Specifically, the report focuses on the current and future military strategy and addresses the current and probable future military technology for the People's Liberation Army.¹³ The report also addresses China's grand strategy, security strategy, and military strategy; developments in China's military doctrine and force structure, including developments

in advanced technologies to enhance China's military capabilities; and the security situation in the Taiwan Strait.¹⁴

The Export Control Reform Act of 2018 prompted United States business concerns because the reform tightened technology trade with the People's Republic of China, a growing market for form United States businesses. These concerns led to the *U.S. Export Control Reforms and China: Issues for Congress* and *U.S. Export Controls and China* Congressional Research Service reports in 2020 and 2022, respectively. Both reports outline the reports undertaken in 2018, and cover topics such as China's Industrial Policies, Dual-Use Export Controls, Licensing Approaches, and the Department of Commerce's Bureau of Industry and Security Entity List. The reports differ in addressing additional reforms since the 2018 reform act and the issues for members of Congress.

The Senate Committee on Banking, Housing, and Urban Affairs held the Committee Hearing on *Implementation of the Exon-Florio Amendment and the Committee on Foreign Investment in the United States* regarding Foreign Investment in the United States. The consensus among the witnesses was that the current Committee on Foreign Investment in the United States process for reviewing foreign acquisition leaves the United States vulnerable to foreign threats, and that the Committee does not have a broad enough conception of United States security to be effective.¹⁵ During the hearing, Senator James Inhofe (R-Oklahoma) cited a few examples of where the Committee failed, including its approval of the Magnequench acquisition.

The End of Export Control is an article by Mr. James Lewis that argues export controls are not a panacea but a relic. Lewis suggests that the United States and China are in a "Cold War" over technology through export controls.¹⁶ Further, Lewis argues that export controls are a

legacy of the Cold War foreign policy that only leads to workarounds, by either foreign nations building their own industries or finding alternative technologies.¹⁷

The testimony of Assistant Secretary of Commerce Kevin Wolf, Bureau of Industry and Security, Department of Commerce for the Hearing before the Committee on Foreign Affairs, United States House of Representatives, discusses the importance of export control reform on national security, how the Bureau of Industry and Security plays a unique role in the export control process, and how the Bureau of Industry and Security has found success in prosecuting violators of export laws. Furthermore, Wolf testified about the complementary controls between the International Traffic in Arms Regulation and Export Administration Regulations, their use in ensuring the United States fidelity under international export control regimes, and the protection of critical technologies through new decontrol measures.

The U.S. Export Control System and the Export Control Reform Act of 2018

Congressional Research Service report outlines the comprehensive changes made by the Export Control Act of 2018. The report gives Congress context on the broad legislative authorities granted to the President for implementing dual-use export controls. The report also emphasizes that the Export Control Reform Act of 2018 conforms to the requirements of several multilateral export control regimes in which the United States participates.¹⁸

3. Illegal Export of Restricted Technologies: Magnequench

Magnequench is a company that specializes in the production of high-performance, industrial rare-earth magnets that have a variety of electronic applications. The factory was located in Valparaiso, Indiana from 1990 to 2000.¹⁹ Reportedly, Magnequench supplied 85 percent of the neodymium magnets used in servo motors for precision-guided munitions and is

the sole reason high-speed, high-capacity computer data storage devices work.²⁰ As of 2004, Magnequench and its merger partner NEO Material Technologies supply about 80 percent of the world's neodymium and rare-earth oxide powders used in all-powerful magnets.²¹

Neodymium-iron-boron magnets are the strongest type of permanent magnets available commercially. Their strength, compact size, lightweight, and resistance to demagnetization make them essential components in numerous civil and military technologies, including guidance systems, missiles, 'smart bombs,' electric vehicles, wind turbines, and various consumer electronics. Neodymium magnets make high-speed, high-capacity computer data storage devices work, and people find them in all computers and smartphones worldwide.

General Motors founded Magnequench as a subsidiary with the explicit purpose of pioneering the manufacturing of high-powered neodymium magnets for airbags and mechanical sensors. During this time, Magnequench became the leading producer of neodymium-iron-boron permanent magnets. In 1995, General Motors divested of Magnequench as part of a company-wide restructure, selling a fifty-one percent majority stake of Magnequench to a consortium by Sextant Group Inc. and MMC Investment Corporation. During this time, Chinese companies and the Chinese Government became interested in securing access to rare-earth materials, including those used in producing neodymium-iron-boron magnets. Due to China's vast reserve of rare earth elements, the People's Republic of China pursued investment and acquisition of advanced magnet technology companies to increase its role within the rare-earth magnets industry worldwide.

In 1995, a Canadian company, MQI Holding Inc., began acquiring a majority stake in Magnequench. MQI Holdings Inc. is a Chinese consortium with ties to two Chinese state-owned metal firms: San Huan New Material High-Tech Inc. and China National Nonferrous Metals

Import and Export Company. San Huan New Material High-Tech Inc. is a state-owned enterprise with significant affiliations with China Nonferrous Metal Mining (Group) Company, Limited. China Nonferrous Metal Mining (Group) Company, Limited is a significant Chinese rare earth mineral industry player, responsible for projects in twenty-seven countries and trade networks in nearly one hundred countries.²² Despite objections from the Department of Defense, the United States magnet industry, and Indiana's State Government, the Committee on Foreign Investment in the United States approved the acquisition.

Under the acquisition agreement, the two Chinese firms owned sixty-two percent of Magnequench shares. A Chinese investor, Mr. Zhang Hong, became the company's chairman and Mr. Archibald Cox Jr, a United States citizen, became the chief executive officer. As part of the agreement, the Chinese companies could not remove the magnet production equipment or jobs from the United States for ten years.²³ In addition to his role at Magnequench, Mr. Hong served as the chairman of San Huan New Material High-Tech Inc. and is the son-in-law of the former Chinese "paramount leader" Deng Ziaoping, now Director of the Research and Development Bureau of the Chinese Academy of Sciences.²⁴ At the time of the acquisition, another of Mr. Ziaoping's sons-in-law was running the China Nonferrous Metal Mining (Group) Company.²⁵ The Chinese government and Mr. Hong's *Super 863 Program* no doubt informed the acquisition of Magnequench to develop and acquire cutting-edge technologies for military applications, including exotic materials for military applications.²⁶

Despite the Committee on Foreign Investment in the United States setting conditions that stipulated Magnequench could not remove its production equipment from the United States for ten years, Magnequench employees began reporting that shortly after the acquisition, the People's Republic of China created a duplicate of Magnequench's neodymium-iron-boron

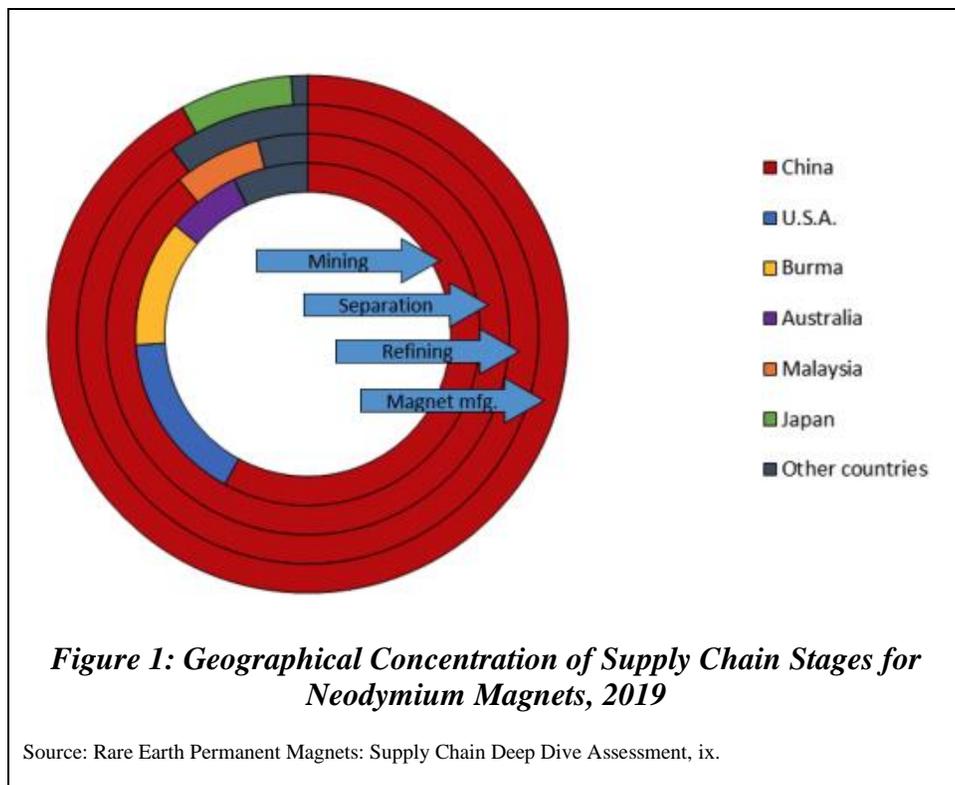
magnet production line in China and ensured its functionality, which led to the shutdown of United States production in Indiana.²⁷ Shortly after, citing demand issues in the United States, in September 2001, Mr. Cox announced the Magnequench production lines would shut down because "almost all of the raw materials for Magnequench's powder products come from China, and 90 percent of our customer base is in Asia."²⁸ This left the United States without a domestic supplier of neodymium magnets.

In 1997, San Huan New Material High-Tech Inc and China National Nonferrous Metals (Group) Company transferred their share of Magnequench to a Chinese state-owned holding company run by Mr. Wu Jianchang, another son-in-law of Mr. Ziaoping.²⁹ Meanwhile, Mr. Cox became the President. In 2003, the Valparaiso factory began applying for permits to export all manufacturing equipment from Indiana to China. This included the equipment that, under the acquisition agreement, would remain in the United States. After all intellectual property and manufacturing equipment was exported, the factory was shuttered in late 2003.

Today, the Magnequench facility in China is the world's largest producer of rare earth powders. However, Magnequench operates a smaller plant in Thailand that produces powders for Japanese hard-drive disk manufacturers. San Huan Hi-Tech, which no longer holds any interest in Magnequench, is now a supplier of neodymium-iron-boron magnet technology. The illegal transfer of the technology from the United States to the People's Republic of China, and the fact neodymium magnets are the sole reason high-speed, high-capacity computer data storage devices work, underpins the importance of rare earth elements in modern technology. In 2005, the aforementioned Senator Inhofe (R-Oklahoma) testified to the Committee on Foreign Investment in the United States that "[t]he United States now has no domestic supplier of rare

earth metals, which are essential for precision-guided munitions. I'd say that's a clear national security concern."³⁰

Further, it demonstrates the geopolitical considerations surrounding their production and supply. The Chinese acquisition of Magnequench, and the subsequent movement of its facilities to China, has left the United States with no domestic supplier of neodymium, a critical component of rare earth magnets.³¹ Almost 20 years later, this remains true, as shown in Figure 1.



4. Dual-use Technologies: Hughes Space and Communications

On February 15, 1996, a Long March 3B rocket carrying the United States-built Intelsat 708 satellite crashed just after launch in Xichang launch center in the People's Republic of China. In a span of thirty-eight months, this was the third launch failure involving a Long March

rocket carrying a United States-built satellite payload. This case study examines how and why, following the failed launch, a review committee led by western engineers provided, without authorization, very sensitive information to the Chinese state-run company that launched the satellite. This information ultimately led to improvements in reliability for all People's Republic of China missile and rocket programs.³² Further, although not the focus, the case study examines how capitalistic values threaten United States national security.

The technology and equipment used in space launch vehicles and intercontinental ballistic missiles are generally similar, if not the same. Figure 2 shows a comparison of satellite launch vehicles and missile technology. The only technology unique to ballistic missiles is the warhead. Through Hughes Space and Communications recommendations, the People's Republic of China significantly improved the manufacturing, production, reliability, and maintainability of space launch vehicles and therefore intercontinental ballistic missiles.

Technology and equipment generally unique to ballistic missiles:

- warhead

Technology and equipment that are similar in SLV and ICBM (comparison requires case-by-case analysis):

- reentry vehicle
- payload separation
- inertial guidance and control systems
- strap-on boosters

Technology and equipment that are same in SLV and ICBM:

- staging mechanisms
- propellants
- air frame, motor cases, liners, and insulation
- engines or motors
- thrust vector control systems
- exhaust nozzles

Figure 2: Comparison of Satellite Launch Vehicles and Missiles.

After the launch failure, Great Wall Industry Corporation reported that a broken wire in the inner frame of the inertial measurement unit within the rocket's guidance system caused the Long March 3B launch failure.³³ In response to pressure from the space launch insurance industry, the Great Wall Industry Corporation invited Dr. Wah Lim, Loral Space & Communications Senior Vice President and General Manager of Engineering and Manufacturing, to chair an Independent Review Committee. Dr. Lim then recruited experts from the satellite launch industry, which included four senior engineers from Loral Space & Communications (U.S.), two from Hughes Electronics (U.S.), one from Daimler-Benz Aerospace (German), and retired experts from Intelsat (U.S.), British Aerospace (U.K.), and General Dynamics (U.S.).³⁴

The Independent Review Commission met twice: once in Palo Alto, California, and a second time in Beijing, China. Great Wall Industry Corporation also had four People's Republic of China aerospace engineers in the first meeting in California and twenty-two in the second meeting in China. The People's Republic of China aerospace engineers included those from Great Wall Industry Corporation, Beijing Control Device Institute, China's Academy of Launch Vehicle Technology, and China's Aerospace Corporation.³⁵ All of these companies and organizations have a role in the People's Republic of China's rocket and missile programs.

The Independent Review Committee reviewed the cause of the launch failure in the People's Republic of China's investigation, ultimately concluding that the People's Republic of China failed to explain the telemetry data obtained from the failed launch sufficiently.³⁶ The Committee further explained that they did not believe a broken wire would connect and

reconnect inflight.³⁷ Lastly, the People's Republic of China's inability to reliably reproduce the issue supported the assertion a broken wire did not cause the launch failures. People's Republic of China engineers could only replicate the failure during testing in eight of twenty-three launches. Following the Independent Review Committee review of available information, they produced a draft report identifying what they believed to be the cause of the launch failures: no current output from the servo-loop of the inertial measurement unit follow-up frame resulting from the deterioration in the fold-aluminum wiring connections within a power amplifier for the follow-up frame. This draft report was sent to Great Wall Industry Corporation without prior review by any United States Government authority, thus violating the export license to not provide technical expertise.³⁸

After receiving the Independent Review Committee's report, the People's Republic of China conducted extensive testing and evaluation, which ruled out their original explanation for the launch failure. Instead, the People's Republic of China's engineers identified the actual cause of the launch failure: the power amplifier in the follow-up frame, as identified by the Independent Review Commission. Chinese engineers of the People's Republic of China ultimately discovered that this issue affected not just the rocket that launched the Intelsat 708 satellite on February 15th, 1996, but it was systemic across all Long March 3B platforms. The engineers also examined other Long March rockets from the same production batch, revealing bad solder joints in a power amplifier to the gimbal torque motor.

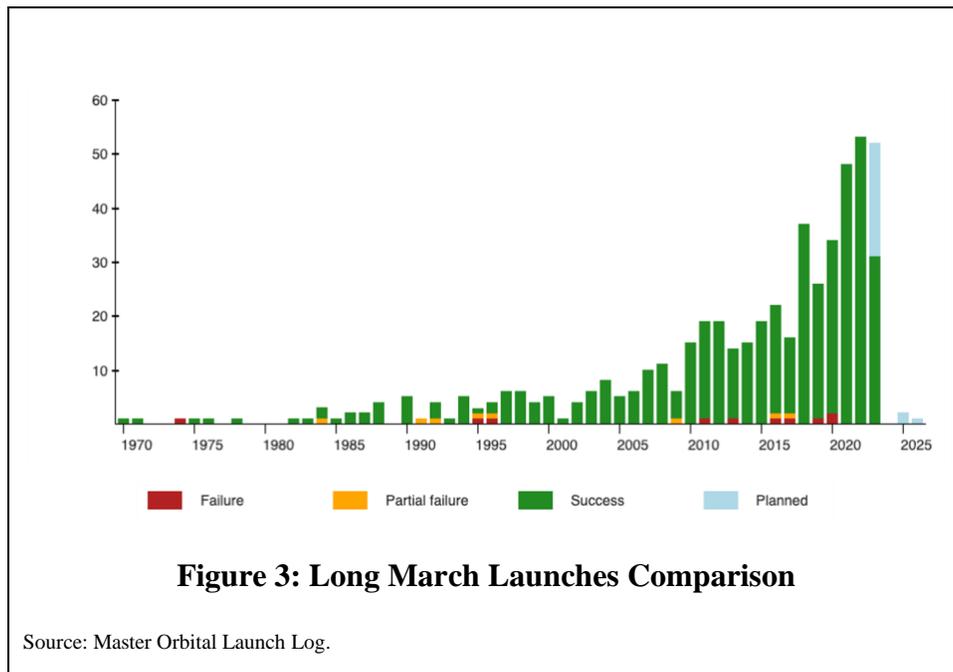
After identifying the cause of the launch failure, the Independent Review Committee provided five short-term and two long-term recommendations. These recommendations not only violated the export license to not provide technical expertise, but significantly improved the manufacturing, production, reliability, and maintainability of space launch vehicles and

intercontinental ballistic missile rockets. The People's Republic of China achieved these significant improvements by setting standards and improving quality control procedures, fault analysis capabilities, test and safety procedures, technical exchange among space launch vehicles, improved wiring and joint connections, and strict acceptance testing. Loral later admitted that, contrary to its policies, the Independent Review Committee provided a report that entailed over 200 pages of data and analysis to the People's Republic of China before consulting with State Department export licensing authorities.³⁹

Exploring what occurred exposes how capitalistic values threaten United States national security. The western engineers, their parent companies, and the satellite launch insurance companies all had financial motivation to assist Great Wall Industries in identifying the cause of the failed Long March 3B missile launch. In 1996, the cost to launch the Intelsat 708 satellite on the Long March 3B in the People's Republic of China was \$140 million.⁴⁰ Without insurance, satellite development companies and space launch companies take a huge financial risk that can result in the loss of millions of dollars in assets and contracts, and international reputation.⁴¹ Further, following a failed launch, insurance companies pay out multi-million-dollar claims. As a result, United States companies – especially insurance companies – have a significant vested financial interest in avoiding launch failures.⁴² Meaning, all parties had a vested interest in improving the People's Republic of China's satellite launch capabilities to avoid costly failed launches, regardless of the national security implications, violations of export laws and licenses, and the International Traffic in Arms Regulation.

Due to Loral Space & Communications and Hughes Electronics' role on the Independent Review Commission, the Great Wall Corporation Industry increased its successful launch rate from eighty-three percent to ninety-nine percent within six months. Figure 3 shows the

successful Long March rocket launches for the People’s Republic of China from 1970 to 2012. In addition to increasing the capabilities of the People’s Republic of China, Loral Space & Communications and Hughes Electronics’ illegal technological transfer led to increased scrutiny of satellite technology transfers and export regulations. Finally, it highlighted concerns about the potential dual-use nature of satellite technology, which could have both civilian and military applications, and the financial and profit motivations driven by capitalistic values.



5. Recruitment Programs: Terfenol-D

Recruitment programs, such as the People’s Republic of China's *1,000 Grains of Sand* and *1,000 Talents Plan*, allow the People’s Republic of China to access sensitive military technologies. The People’s Republic of China’s access to these sensitive military technologies challenges the United States’ military dominance and technological advantage. The Committee on Homeland Security and Governmental Affairs’ *Report to the Permanent Subcommittee on*

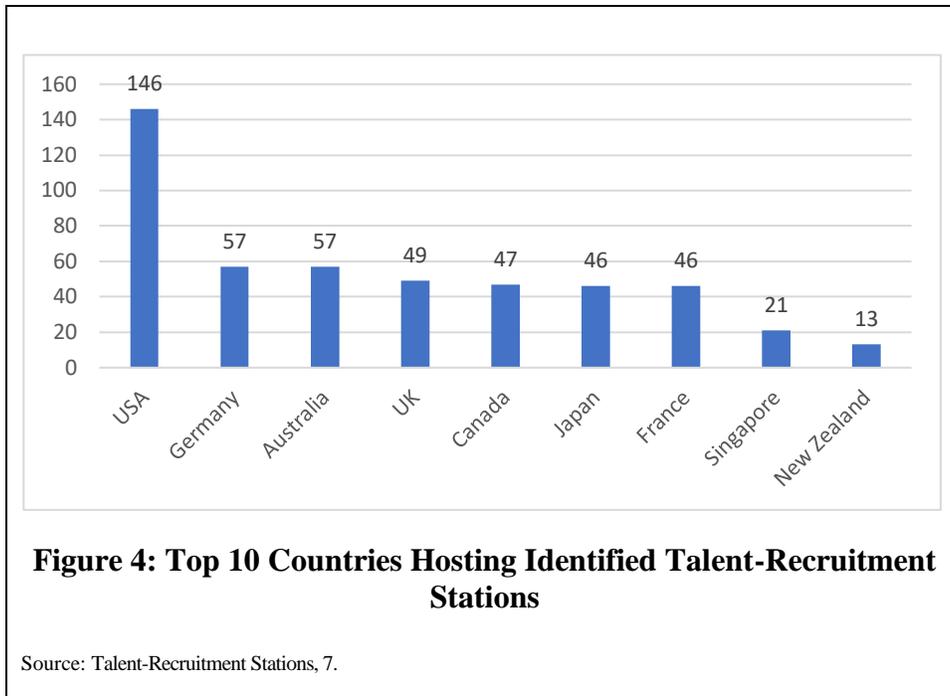
Investigations on Threats to the U.S. Research Enterprise: China's Talent Recruitment Plans outlines how the People's Republic of China designed *1,000 Talents Plan* to recruit 2,000 high-end overseas talents, including scientists, engineers, entrepreneurs, and financial experts.⁴³ It further describes how the plan provides salaries, research funding, lab space, and other incentives to lure experts into researching for the People's Republic of China.⁴⁴ By 2017, the People's Republic of China had recruited more than 7,000 high-end professionals, including several Nobel laureates.⁴⁵

The People's Republic of China devoted extensive resources to stealing Terfenol-D, a metal alloy that converts electrical power to mechanical power. In this case, the People's Republic of China took advantage of technical information transfers that often occur in academic exchanges between scientists and students working to solve related scientific problems. The People's Republic of China took advantage of this exchange of ideas by placing students at Iowa State University, which the United States Navy contracted to develop Terfenol-D, to work in and around the laboratory where the research was taking place. Following public testimony about the *1,000 Talents Plan*, online references to the plan disappeared in October 2018.⁴⁶ Specifically, Chinese Universities ceased promoting the program on their websites, advised talent recruitment programs to avoid the phrase *1,000 Talents Plan* in written circulars and notices, and removed the names of participants from the official *1,000 Talents Plan* website.⁴⁷

1,000 Grains of Sand is a concept the People's Republic of China uses to collect information from various sources that provide clues and inferences when put together. This concept can sometimes derive classified information on protected and critical technologies. Overall, the People's Republic of China employs *1,000 Grains of Sand* by using Chinese students, academics studying and working abroad, tourists, and companies to gather information.

Most of the collected information is of low quality, requiring a time-consuming process to analyze all available information to piece together a bigger picture. The information collected is not just on sensitive or critical technologies; *1,000 Grains of Sand* is like a vacuum cleaner that takes in all available information regardless of subject.

1,000 Talents Plan is the People's Republic of China's sponsored talent recruitment program to bring outside knowledge and innovation back to the People's Republic of China, sometimes stealing trade secrets, breaking export control laws, or violating conflict-of-interest policies.⁴⁸ Chinese organizations, such as the Thousand Talents Think Tank, will recruit science and technology professors, researchers, students, and others—regardless of nationality or citizenship to steal foreign technologies needed to advance China's national, military, and economic goals.⁴⁹ The People's Republic of China has established hundreds of overseas talent recruitment workstations in countries with high-quality talent, cutting-edge industries, and advanced technologies.⁵⁰ Figure 4 shows the top ten countries with known talent recruitment stations. Both *1,000 Grains of Sand* and *1,000 Talents Plan* have been actively employed to steal technologies, such as Terfenol-D.



Terfenol-D is a crystal metal alloy that converts electrical power into mechanical power and vice versa through magnetostriction. Magnetostriction occurs when a material changes shape or dimension when subjected to a magnetic field. When the magnetic field reverses, it causes Terfenol-D to return to its original shape. With a high magnetostrictive property, Terfenol-D is ideal, and thus a popular choice, for sensors and actuator devices. The United States Navy uses Terfenol-D in many of its technologies, including submarine sonar devices to detect and track adversary vessels within 10,000 kilometers.⁵¹ Due to its use in sonars, it is a dual-use technology.

Mr. Arthur Clark developed Terfenol-D in the 1970s, but affordable manufacturing proved difficult. To overcome the affordability of its production, Clark turned to the leading experts of rare earth materials: the Department of Energy's Ames Laboratory at Iowa State University.⁵² Ames Laboratory subsequently contracted with Etrema to produce Terfenol-D; Etrema was the only United States company authorized to work with Terfenol-D by the United

States Navy.⁵³ Although Terfenol-D was commercially available by 2000, possession of the material would not, by itself, reveal the process used to create it.⁵⁴

To produce Terfenol-D, one had to know the process, which the United States Navy and Ames Laboratory tightly guarded. Around 2000, the People's Republic of China began placing students at the Ames Laboratory, where they worked for scientists working on the Terfenol-D project.⁵⁵ While working for these scientists, students gleaned information on the process of creating Terfenol-D through academic "problem-solving discussions."⁵⁶ One student later admitted to giving the People's Liberation Army the information he gleaned on how to make Terfenol-D to develop a crude version of it.⁵⁷ Another international student who had worked in the People's Republic of China's Terfenol-D program took a position at Pennsylvania State University, where Terfenol-D was also under research for the United States Navy, and earned his Ph.D. A Chinese company, Gansu Tianxing Rare Earth Functional Materials Company Limited, later claimed to have independently developed Terfenol-D.⁵⁸

By acquiring a crude version of Terfenol-D, the People's Republic of China can improve its military capabilities. Terfenol-D has various applicability in high-tech sonar devices, military underwater sonar, marine engineering, ultra-precision machine tools, fuel injection valves, and aircraft wing control, as well as a multiple warhead missile stage and "smart" aircraft wings in advanced aircraft and spacecraft.⁵⁹ Today, both Terfenol-D and its successor, Galfenol, are under academic research in China, presumably with the help of researchers, like those at Ohio State University, who collaborate with PRC students on Galfenol projects.⁶⁰ Further, the scientific literature contains research published by American and Chinese academics working together.⁶¹

6. Inaction in the Face of Theft: How the United States Responded

The United States has had varying responses to the illegal acquisition or transfer of protected technologies to the People's Republic of China. In the case of Magnequench, the United States Government did nothing. Shortly after the announcement of the factory closure, Representative Peter Visclosky (D-Indiana) and Senator Evan Bayh (D-Indiana) requested the intervention of the George W. Bush Administration using the Exon-Florio Amendment in the 1988 Defense Appropriations.⁶² The Administration did not use the Exon-Florio Amendment to stop the factory closure.⁶³ Further, the Department of Treasury did not intervene by placing the Chinese owners of Magnequench in receivership, effectively barring Chinese officials from having access to Magnequench facilities.⁶⁴ Although these actions would not have stopped the technology transfer, they would have kept the production of neodymium-iron-boron magnets within the United States for domestic use.

For almost two years, the Department of Justice conducted a criminal investigation into Loral Space & Communications and Hughes Electronics for transferring technical expertise to the People's Republic of China, which significantly enhanced the guidance and control systems of its nuclear ballistic missiles and caused harm to United States national security. The Department of Justice and the Department of State settled with Loral Space & Communications and Hughes Electronics in January 2002.⁶⁵ Without admitting or denying the government's charges, Loral agreed to pay a civil fine of \$14 million and spend at least \$6 million strengthening its export control compliance program.⁶⁶ In December 2002, the Department of State issued a letter charging Hughes Electronics with 123 violations of the Arms Export Control Act and the International Traffic in Arms Regulation. In March 2003, Hughes Electronics settled with the Department of State, paying a \$32 million civil penalty, while admitting the assistance

they provided could aid the People's Republic of China in developing missile system technology."⁶⁷ Both companies and the members of the Independent Review Commission avoided criminal prosecution by the Department of Justice.⁶⁸

After Gansu Tianxing Rare Earth Functional Materials Company Limited produced a crude version of Terfenol-D, hackers targeted Etrema, and customers began receiving advertisements for Terfenol-D from Gansu Tianxing Rare Earth Functional Materials Company Limited. In September 2016, Etrema filed for bankruptcy, citing mounting rental bills from Ames Research Park and losing customers to Gansu Tianxing Rare Earth Functional Materials Company.⁶⁹ They subsequently sold their research and intellectual property assets to TdVib, LLC, a company specializing in magnetically activated smart materials and electromagnetic technologies in Ames, Iowa.⁷⁰

7. Securing the Future: The Way Forward

The United States must re-evaluate its export rules and regulations and its hesitance to prosecute those responsible for illegal technical transfers. This would involve many organizations within the United States Government, including the Departments of Commerce, Defense, Justice, and State. Companies under investigation for illegal technology transfers often settle with the Departments of State, Commerce, and Justice to avoid prosecution. Future settlements should include criminal prosecutions of those responsible. There is no doubt Magnequench, Loral Space & Communications, and Hughes Electronics violated the International Traffic in Arms Regulation and export control laws; failing to prosecute them criminally allows those responsible to avoid accountability. Additionally, all settlements with the Departments of Commerce and State should automatically include the revocation of all

current export licenses and a ban on issuing export licenses to companies and individuals, associated with violating United States export regulations or otherwise participating in illegal technological transfers for at least ten years. Lastly, the Department of State should revoke the visas of international students and foreign employees who illegally provide protected technical information to the People's Republic of China while the Department of Justice criminally prosecutes them.

This solution will require a whole of government approach involving highly controversial policies and diplomatically sensitive topics towards the People's Republic of China and its practices in gathering technical information from United States citizens and corporations or recruiting Chinese nationals abroad. Further, it requires a strategic and national policy change affecting export rules, regulations, and practices. The long-term consequences of allowing foreign nations to circumvent our export policies and gain critical technologies could impact the Marine Corps' modernization efforts under *Force Design 2030*, the United States military's ability to compete strategically, and the *Joint Warfighting Concept 3.0* implementation. Taking drastic measures, like prosecuting companies and individuals who violate export laws and revoking export license, will send a clear message to corporations and individuals who willingly illegally transfer protected technology to foreign nations.

8. A Case for Change: A Counterargument to Increased Enforcement and Oversight

This Master's research paper argues for changes in enforcing the existing export rules and regulations. However, one can argue that the examples of Magnequench, Loral Space & Communications, Hughes Electronics, and the recruitment program demonstrate that the current rules, regulations, and policies are implemented as intended. However, foreign nations and

United States companies are finding ways around them, if not blatantly ignoring them.

Therefore, the United States Government does not need better implementation or enforce these rules but to rewrite the export rules and regulations to ensure that enforcement and accountability do not result in inaction.

This position, however, is untrue. Suppose the United States Government better enforced the current processes through criminal prosecutions, withdrawal or denial of export licenses, and revocation of visas of those who willingly violate export laws. In that case, the current laws will be more effective and continue to protect United States industries, companies, and military technologies and capabilities. For every Magnequench, Loral Space & Communications, or Hughes Electronics, there are numerous cases where companies comply with the United States export rules and regulations and successfully protect critical technologies. Huawei Technologies Company, Limited is a perfect example.

As outlined in the Congressional Research Service In Focus reports *U.S. Export Control Reforms and China: Issues for Congress* and *U.S. Export Controls and China*, since 2018, the United States Government has increased its use of the Department of Commerce's Bureau of Industry and Security Entity List to restrict dual-use technology trade. The Trump Administration added Huawei Technologies Company, Limited, to the Bureau of Industry and Security Entity List. Since then, export licenses to Huawei have drawn heavy scrutiny. From November 9, 2020 to April 20, 2021, there were 169 export applications, with 113 approved. Figure 5 breaks down the export licenses by classification. In January 2023, the Biden Administration stopped approving licenses for United States companies to export most items to Huawei Technologies Company, Limited.⁷¹

Approvals by Export Classification

Classification	Total Approvals
Category 3 (Electronics Design Development and Production)	7
Category 5 (Telecommunications/Information Security)	1
Items controlled for Antiterrorism reasons only (typically do not require an export license to China)	25
EAR 99 (typically do not require an export license to China)	80
Category 3 (Electronics Design Development and Production)	7

Returned Without Action by Export Classification

Classification	Total RWAs
Category 6 (Naval Vessels and Special Naval Equipment)	1
Items controlled for Antiterrorism reasons only	6
EAR 99	41

Denials by Export Classification

Classification	Total Denials
Items controlled for Antiterrorism reasons only	1
EAR 99	1

Note: Export Administration Regulations (EAR) 99 is a classification for items subject to EAR but not controlled for a specific reason, therefore lacking an Export Control Classification Number on the Commerce Control List.⁷²

Figure 5: Nov 9, 2020 – Apr 3, 2021 Huawei Export Licensing Decisions

Source: BIS Releases Statistics on Export License to Huawei and SMIC Showing Majority of License Applications Were Approved.

10. Paradigm Shifts: Conclusion

Every country will look within itself and to those around it – friendly and adversarial – for the next technological advantage. These advances and modernizations range from improving the everyday lives of citizens to increasing military lethality on the battlefield. Some of these technologies are so critical, revolutionary, or sensitive that they necessitate export restrictions,

regulation, and classification protection. These illegal exports, exploitation of capitalistic values, and use of recruitment programs to gain access to sensitive technologies and programs allow foreign nations to increase their military capabilities with minimal investment of resources.

Foreign nations illegally export technologies after acquiring United States companies, often shutting down domestic factories. Meanwhile, when it is in their best interest, United States companies violate export restrictions by providing expertise on dual-use technologies. Further, recruitment programs, like *1,000 Grains of Sand* and *1,000 Talents Plan*, gain foreign nations access to sensitive technologies, research, and subject matter experts. These methods result in significant military gain for the People's Liberation Army and other foreign nations that employ them.

This Master's research paper focused on three case studies to demonstrate how foreign nations exploit illegally exported technologies, capitalistic values, and recruitment programs to gain access to sensitive technologies and programs for their military gain. Furthermore, coupling this exploitation with the Department of Justice's continued inaction undermines deterrence and allows our adversaries to gain critical technologies. Left unchanged, these vulnerabilities will continue to allow our adversaries to access sensitive military technologies, subject matter experts, and dual-use technologies, ultimately threatening the United States' technological advantage on the battlefield.

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