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HUMAN CAPITAL: A SYSTEM DYNAMICS APPROACH

by

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Human capital management is a complex and often misunderstood concept for today's military organization, which requires planning for accession, talent competition and cost controls within a dynamic environment. Throughout history, the manpower required to maintain a standing military during peacetime has always been subject to a combination of the external and internal effects of competing interests over budgetary concerns and the military requirement to support national strategy. Management science has shown how to design and implement the most effective policies, but in today's dynamic environment containing emerging threats and economic opportunity, military manpower struggles to meet strategic goals. This thesis fills a gap in the literature by examining human capital management from a warfare design perspective, with a systems approach interplay to address specific resource constraints and courses of action.

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HUMAN CAPITAL: A SYSTEM DYNAMICS APPROACH

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ABSTRACT

Human capital management is a complex and often misunderstood concept for today's military organization, which requires planning for accession, talent competition and cost controls within a dynamic environment. Throughout history, the manpower required to maintain a standing military during peacetime has always been subject to a combination of the external and internal effects of competing interests over budgetary concerns and the military requirement to support national strategy. Management science has shown how to design and implement the most effective policies, but in today's dynamic environment containing emerging threats and economic opportunity, military manpower struggles to meet strategic goals. This thesis fills a gap in the literature by examining human capital management from a warfare design perspective, with a systems approach interplay to address specific resource constraints and courses of action.

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LIST OF ACRONYMS AND ABBREVIATIONS

AETC	Air Education and Training Command
AFPC	Air Force Personnel Center
AFROTC	Air Force Reserve Officer Training Corps
AI	artificial intelligence
AvB	aviation bonus
AVF	all-volunteer force
AvIP	aviation incentive pay
BRAC	base realignment and closure
C2	command and control
C4I	command, control, communications, computers, and intelligence
CBO	Congressional Budget Office
CLD	causal loop diagram
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
FTU	field training unit
FFDRC	Federally Funded Research Centers
GAO	Government Accountability Office
GDP	Gross Domestic Product
HCM	human capital management
HRC	Human Resources Command
ICBM	intercontinental ballistic missile
IFT	initial flying training
ISIS	Islamic State of Iraq and Syria
JCPOA	joint comprehensive plan of action
LRSO	long-range stand-off
MAGTF	Marine Air-Ground Task Force
MEU	Marine Expeditionary Unit
NATO	North Atlantic Treaty Organization
NBA	National Basketball Association
NDA	National Defense Act

NDS	National Defense Strategy
NMS	National Military Strategy
O&M	operations and maintenance
OTS	officer training school
PLA	People's Liberation Army
ROTC	Reserve Officer Training Corps
RPA	remotely piloted aircraft
SLBM	submarine/sea-launched ballistic missile
START	Strategic Arms Reduction Treaty
TFM	total force management
UMT	Universal Military Training
UN	United Nations
USAF	United States Air Force
USAFA	United States Air Force Academy
USMA	United States Military Academy
VEO	Violent Extremist Organization

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I. INTRODUCTION

A. THE PROBLEM

The 2017 National Security Strategy (NSS) and the 2018 National Defense Strategy (NDS) have asked all Department of Defense branches to rethink how they organize, train, and equip their forces to prepare for next-generation warfare. This approach means the services need to grow their force to meet the demand signal in the national guidance.[1] In addition, the militaries must win wars. So, it is not enough to simply have the people. The people filling the military's ranks will have to be the best. This qualitative condition inherent in warfighting complicates what may initially seem like a simple quantitative problem. Making matters worse, the Air Force intends to draw upon its pilots to fill manning vacancies in the newly established Space Force. Recruiting and retaining human capital is now the primary concern for a Service asked to increase highly technical and marketable manning numbers.

The 2011 withdrawal of U.S. Forces from Iraq and the steady reduction of troops from Afghanistan have led to the rapid depletion of those with direct combat experience throughout the ranks of the U.S. military.[2] Faced with great power competition and growing fiscal constraints exacerbated by an additional publicly held federal budget deficit approaching $2T, military service chiefs have said they are in a war for talent.[3] This talent search represents a national security concern that may limit the services' ability to provide sufficient inducements to sustain an all-volunteer force at a time when the number of eligible recruits has been trending downward. The military needs to retain its top talent

[1] Paul Larson, "The Power of Numbers: Challenges of Rapidly Expanding the Army," *War Room - U.S. Army War College* (blog), February 13, 2019, https://warroom.armywarcollege.edu/articles/the-power-of-numbers/.

[2] Jeff Schogol, "Where Have All the Combat Vets Gone?," Marine Corps Times, September 13, 2018, https://www.marinecorpstimes.com/news/2017/08/14/where-have-all-the-combat-vets-gone/.

[3] Christopher Woody, "The Military's 'war for Talent' Is Affecting What the Navy's Future Ships Will Look like - We Are The Mighty," April 2020, https://www.wearethemighty.com/mighty-trending/talent-affecting-navy-future-ships/.

while growing a lethal and ready force of highly qualified professionals to deter an adversary's threat.[4]

For Air Force, this problem is especially pertinent. In the past, Air Force leaders have been accused of recruiting pilots and encouraging their retention while requiring them to perform an increasingly large number of collateral duties that prevent them from flying.[5] Administrative duties aside, many other factors influence a pilot's decision to leave the Air Force. The assignment selection process, long deployment rotations, and remote duty stations appear to be primary reasons pilots leave the military for commercial prospects. Recruiting and retaining human capital is now a primary concern for a Service asked to increase manning numbers in a highly technical and financially profitable career field. Add to that the 30,000 civilian pilots expected to retire over the next ten years, and the attractiveness of the civilian market makes the pilot shortage worse.[6]

This thesis explores warfare-centric human capital management from a strategic design perspective. It employs system dynamics modeling to analyze *how the Air Force can achieve an end strength of 21,000 pilots by* 2030.[7]

B. BACKGROUND

Since the republic's founding, a general distrust of standing militaries has driven America's civilian population to supply troops for the country's primary defense.[8] This

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[4] Hugh Harsono, "Losing the Strategic 'Battle' AAgainst the PRC (But Not The 'War'): Part II – Talent Management," *War Room - U.S. Army War College* (blog), June 2020, https://warroom.armywarcollege.edu/articles/talent-management-pt2/.

[5] Taylor, Moore, and Roll, "The Air Force Pilot Shortage," 3–7.

[6] Office of the Under Secretary of Defense for Personnel and Readiness, "Report to Congressional Armed Sevrices Committees on Inititiatives for Mitigating Military Pilot Shortfalls," July 2019, https://prhome.defense.gov/Portals/52/Documents/Report%20to%20Congress%20on%20Initiatives%20for%20Mitigating%20Military%20Pilot%20Shortfalls%20cleared%20for%20public%20release.pdf, 5–7.

[7] The Air Force has determined it needs approximately 12,800 pilots, 3,800 Air National Guard pilots, and 3,600 reserve pilots. In addition to manned aircraft pilots, the service also requires 4,500 combat system officers, 2,000 battle managers, 3,300 RPA pilots, and 15,000 enlisted airmen to make the entire system work.

[8] James Carafano, "The Draft Should Be Left Out in the Cold," The Heritage Foundation, accessed March 11, 2021, https://www.heritage.org/defense/commentary/the-draft-should-be-left-out-the-cold.

opposition to a large military led the U.S. to call up forces when needed and then disband these forces when the nation was not at war. A combination of volunteers and conscripts had filled the forces' ranks when manning for strategic defense requirements fell short. In 1973, the U.S. underwent a seismic shift by abandoning its conscription policy in favor of an all-volunteer force (AVF).

The decision to change from conscription to the military's current system of volunteers reflected the American public's disapproval of warfighting activities from 1950 to 1973. Rostker's research highlighted the challenges in moving the government from conscription to the military's current system of volunteers. The key to the policy change was that America's foreign policy interests were influenced by public disapproval of warfighting activity over the previous 23 years.[9] Today, the American public appears to be just as war-weary as it was when it transitioned to the AVF in 1973.[10]

Diverging from a build-up/draw-down pattern, the military's transition from conscription to an AVF created a large-standing force with significant costs associated with providing benefits and allowances. What was once a conscription force of unmarried 18-year-old males became a population of mature professionals, many of whom had families.[11] In addition, the demography of the force changed dramatically after the Cold War. This demographic shift created a perpetual competition for talent between the military and private enterprises.[12] Military service became one career choice among many afforded by the American economy and now subject to the same forces and economic trends that affected businesses and corporations.

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[9] Bernard D. Rostker and K. C. Yeh, *I Want You!: The Evolution of the All-Volunteer Force* (Santa Monica, UNITED STATES: RAND Corporation, The, 2006), 2.

[10] Ruth Igielnik and Kim Parker, "Majorities of U.S. Veterans, Public Say the Wars in Iraq and Afghanistan Were Not Worth Fighting" (Pew Research Center, July 2019), https://www.pewresearch.org/fact-tank/2019/07/10/majorities-of-u-s-veterans-public-say-the-wars-in-iraq-and-afghanistan-were-not-worth-fighting/.

[11] Lawrence J. Korb and David R. Segal, "Manning & Financing the Twenty-First-Century All-Volunteer Force," American Academy of Arts & Sciences, 2011, https://www.amacad.org/publication/manning-financing-twenty-first-century-all-volunteer-force.

[12] Korb and Segal.

As economic trends have shaped strategic business management in the private sector, governments and their militaries have responded to these trends in kind. The U.S. government has significantly changed recruiting and retention policies, including career opportunities, education, and pay and benefits, to keep military service compensation competitive with the civilian job market. Additionally, just as American businesses have relied heavily upon technology to grow and compete, so has the military. Modern combat today involves a blend of advanced communication systems, precision-guided munitions, unmanned vehicles, artificial intelligence, and next-generation weapon systems and platforms (to include fighter aircraft). The same basic knowledge and skills required to operate these weapons systems are also highly prized by civilian employers. Private enterprises have long sought employees with backgrounds in mathematics, science, and engineering in competition with military manpower interests.[13]

America now has its smallest military force since the Vietnam War.[14] This force is produced from a diminishing eligible population of citizens.[15] The Army has identified that approximately 70 percent of the military-aged population do not qualify for military service based on health, education, and physical fitness factors.[16] As a result, the Navy,[17] Marine Corps,[18] and Air Force[19] have experienced their own recruiting difficulties. Research has long shown that military recruiting capability is directly linked to the U.S.

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[13] Cindy Williams, *Filling the Ranks: Transforming the U.S. Military System* (The MIT Press, 2004), 2–6.

[14] Amanda Barroso, "The Changing Profile of the U.S. Military: Smaller in Size, More Diverse, More Women in Leadership," *Pew Research Center* (blog), September 2019, https://www.pewresearch.org/fact-tank/2019/09/10/the-changing-profile-of-the-u-s-military/.

[15] Barroso, "The Changing Profile of the U.S. Military."

[16] Nolan Feeney, "Pentagon: 7 in 10 Youths Would Fail to Qualify for Military Service," Time, June 2014, https://time.com/2938158/youth-fail-to-qualify-military-service/.

[17] Mallory Shelbourne, "Navy Recruiting Could See Changes Following Diversity Listening Sessions," *USNI News* (blog), April 7, 2021, https://news.usni.org/2021/04/07/navy-recruiting-could-see-changes-following-diversity-listening-sessions.

[18] Lolita C. Baldor, "Military Recruiting Struggles Amid COVID-19 Crisis | RealClearDefense," April 6, 2020, https://www.realcleardefense.com/articles/2020/04/06/military_recruiting_struggles_amid_covid-19_crisis_115175-full.html.

[19] Stephen Losey, "Air Force Aims to Modernize Recruiting amid Growing Challenges," Air Force Times, November 2, 2018, https://www.airforcetimes.com/news/your-air-force/2018/11/02/air-force-aims-to-modernize-recruiting-amid-growing-challenges/.

unemployment rate. Bicksler and Nolan, for example, identified that a 10 percent decrease in the unemployment rate would reduce the rate of "high-quality" enlisted recruits by 2–4 percent.[20] Although the authors could not establish a positive correlation for recruiting when the unemployment rate increases, they identified a downward trend in the quality of enlisted recruits across all services.[21]

This topic's relevance continues even as strategic priorities have changed. Since 2001, the continuing Global War on Terrorism and the emergence of new strategic competition from Russia and China have prompted demands for America's military to grow its conventional force. The 2017 NSS[22] and the 2018 NDS[23] have led all Department of Defense branches to rethink how they organize, man, train, and equip their forces to prepare for next-generation warfare. This thesis draws on previous research in the following interrelated areas: strategic human capital management, strategic competition, force, structure, and system dynamics.

1. Strategic Competition

This research's primary impetus is the need to provide national security in the face of growing strategic competition. The effects of globalization in the late 1970s and the subsequent development of innovations in micro-processing, mobile phones, the internet, social media platforms, online trading, and various other technologies have brought markets into more direct competition. Horowitz et al. describe "macro changes" in advanced technology that have had a dynamic effect on the balance of power and have resulted in a "new era" of strategic competition.[24] Specifically, their work draws attention

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[20] Barbara A. Bicksler and Lisa G. Nolan, "Recruiting an All-Volunteer Force: The Need for Sustained Investment in Recruiting Resources-An Update" (Arlington, VA: Institute for Strategic Analysis, 2009),1-3.

[21] Bicksler and Nolan, 2.

[22] Donald J. Trump, "National Security Strategy (NSS)" (Washington, DC: White House, 2017), 20–21, 28.

[23] Jim Mattis, "Summary of the 2018 National Defense Strategy," *U.S. Department of Defense*, 2018, 14.

[24] Michael C. Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics*, Course Book (Princeton, NJ: Princeton University Press, 2010), https://doi.org/10.1515/9781400835102.

to next-generation weapons systems and identifies trends in education and other human skills that machines cannot yet reproduce.[25]

In addition to the effects of technology, many scholars believe strategic competition from Russia and China will shape future U.S. military force structure policy.[26] As suggested by Christensen, the future conflict will be different than wars we have fought in the past and those we are fighting now. A new type of competition is afoot, one for which the U.S. may not be entirely prepared.[27] Further, McFate identifies systemic challenges that have shaped worldwide volatility and redefined strategic competition. McFate refers to this as "durable disorder" and asserts that it is the defining characteristic of the coming age of warfare.[28] He blames U.S. strategic atrophy as the primary contributing factor for the failure to understand these "new rules" of war and claims strategic education begins too late in the careers of military servicemembers and is practically nonexistent in civilian institutions.[29] McFate views these issues as elements in a complex system and concludes his work by calling on the U.S. to develop strategic thinkers who can fundamentally reform force structure.[30]

2. Current Force Structure

While there is much academic research focused on the general military force structure,[31] various government organizations and Federally Funded Research and Development Centers (FFRDCs) publish periodic policy and budget analyses on the subject. Among the most authoritative is the Congressional Budget Office (CBO). In 2016,

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[25] Michael C Horowitz et al., "Strategic Competition in an Era of Artificial Intelligence," July 2018, 27.

[26] Mark Gunzinger, "Shaping America's Future Military Toward a New Force Planning Construct," *Center for Strategic and Budgetary Assessments*, 2013, 68, https://csbaonline.org/uploads/documents/CSBA_ForceStructure-Report-web.pdf, 35–7.

[27] Christensen, 33–5.

[28] Sean McFate, *The New Rules of War: How America Can Win- against Russia, China and Other Threats* (New York, NY: William Morrow, an Imprint of HarperCollins Publishers, 2020), 5.

[29] McFate, 235.

[30] McFate, 37.

[31] Congress of the United States Congressional Budget Office, "The U.S. Military's Force Structure: A Primer," July 2016, 1.

the CBO published *The Military's Force Structure: A Primer* to offer insight into the DOD's operating and sustainment activities and supporting budget allocations. This report includes organizational-level personnel data and associated costs.

In addition to the CBO, the RAND Corporation (RAND) has offered insight into "longitudinal trends" in U.S. military force structure and standing military force "traditions." Lewis addressed how the strategic environment influenced these trends and traditions,[32] and his work captures the complex relationship between the history of the U.S. security environment and force structure. Furthermore, RAND's recent four-part series entitled, *Evolution of Military Policy* provides insight into the historical and future design of military force structure. It raises interesting questions about defense manpower policy and challenges traditional thought behind maintaining a large, standing military.[33]

It explains that while force structure is shaped by the Executive Branch's national security objectives, the employment of force to meet these objectives is subject to congressional debate structure.[34]

3. Human Capital and System Dynamics

Human capital is defined as the useful skills and knowledge people acquire as part of their participation in economic and labor activities.[35] Schultz claimed that much of what we currently view as expenses, such as education, healthcare, and even leisure, are direct investments in a population's human capital[36] that can improve production, thereby increasing national economic wealth. In the spirit of Schultz's research, the Air Force could make the case that it already views its service members as a form of human capital. It offers extensive technical training, a wide array of academic programs, competitive pay, healthcare, and vacation compensation to more than 350,000 members. Yet, despite these

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[32] Kevin N. Lewis, "Historical U.S. Force Structure Trends: A Primer," January 1, 1989, 2.

[33] Gian Gentile, Michael E. Linick, and Michael Shurkin, "The Evolution of U.S. Military Policy from the Constitution to the Present," May 4, 2017, 4.

[34] Gentile, Linick, and Shurkin, v–vii.

[35] Theodore William Schultz, *Investment in Human Capital; the Role of Education and of Research* (New York: Free Press, 1970), 3.

[36] Schultz, 3.

investments, and the size of the population, the Air Force manning system has experienced a decades-old pilot shortfall. The persistence of this manning shortage suggests current policies are only addressing part of a much larger system. Perhaps thinking about the pilot manning problem from a systems perspective could lend some insight.

Meadows has claimed that ever since the Industrial Revolution, American institutions have relied on a scientific approach, albeit largely reductionist in nature, to govern, manage, and educate.[37] This approach to problem-solving typically eschews holistic views, which embrace system structures as the source of their own problems. System dynamics is a modeling approach to problem-solving that accounts for dynamic behaviors often found in system structures.[38] In 1961, Forrester claimed that social systems are significantly harder to understand and influence than physical systems. He demonstrated how modeling could improve the understanding of structures and the resulting dynamic properties of a system. Systems, he explained, "consist of interconnected variables, feedback loops, and associated time delays leading to nonlinearities that result in dynamic behaviors over time."[39] Perhaps by integrating the human capital views from Schultz and system dynamics from Forrester, the Air Force can better understand and effectively address their pilot manning problems.

C. RESEARCH GAP – HCM AND MILITARY FORCE STRUCTURE

Over the last 120 years, the perception of managing people has transformed from an onerous chore, often considered a harsh reality of conducting business, to one of new value creation within the business enterprise. Taylor described management as a science capable of creating value through conservation and efficiency. He believed management science contained its own "laws, rules, and principles, as a foundation."[40] Fayol described

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[37] Donella H. Meadows, *Thinking in Systems: A Primer* (White River Junction, Vt: Chelsea Green Pub, 2008), 4.

[38] Jay Wright Forrester, *Principles of Systems*, 2nd prel. ed. (Wright-Allen Press, 1971), 3.

[39] Forrester, *Principles of Systems*, 2–3.

[40] Frederick Winslow Taylor, *The Principles of Scientific Management* (New York (State): Harper & Brothers, 1911), 7.

management as the interaction of "value creation and administration."[41] Additionally, Fayol wrote that only "close collaboration" with science could prepare organizations for the uncertainty found in their respective strategic environments. Together, these early definitions represent something exciting within management science: the concept of recognizing organized value creation in the context of a strategic environment.

Subsequently, as strategic environments have changed over time, the language used to describe management practice has also changed. Taylor and Fayol's "personnel management" of the 1920s grew into "human resource management" during the rapid globalization of the 1970s.[42] In 1971, economist Theodore Schultz conceptualized human capital as "all human abilities either innate or acquired" in his seminal work *Investment in Human Capital*.[43] In 1999, Bontis and his fellow researchers provided the following description of human capital:

> Human capital represents the human factor in the organization; the combined intelligence, skills, and expertise that gives the organization its distinctive character. The organization's human elements are capable of learning, changing, innovating, and providing the creative thrust that if properly motivated can ensure the organization's long-term survival.[44]

In 2002, Scarborough and Elias continued Schultz's and Bontis' work and described human capital management (HCM) as a "bridging concept" that illustrates the connection between human resources management and strategic management.[45] Today, nearly 20 years later, their description still applies. While academic definitions serve as a starting point for understanding concepts, military organizations must take these concepts and translate them into processes to build military organizations.

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[41] Armand Hatchuel and Blanche Segrestin, "A Century Old and Still Visionary: Fayol's Innovative Theory of Management," European Management Review 16, no. 2 (Summer 2019), 399–412.

[42] Morgen Witzel, *A History of Management Thought* (Milton Park, Abingdon, Oxon ; Routledge, 2011), 140–144.

[43] Schultz, 5.

[44] Nick Bontis et al., "The Knowledge Toolbox:: A Review of the Tools Available to Measure and Manage Intangible Resources," *European Management Journal* 17, no. 4 (1999): 391.

[45] Angela Baron and Michael Armstrong, *Human Capital Management: Achieving Added Value Through People* (Kogan Page Publishers, 2007), 2.

Within the DOD, the three military services have interpreted human capital management differently according to their understandings of the concept.[46] HCM in the business arena is called Total Force Management (TFM) in the military. Subsequently, as each department is responsible for their force planning, force structuring, and force development functions, they also have unique processes related to these functions. These processes are designed to recruit, organize, train, and equip the services to accomplish specific security objectives, but each service's process is unique. The Army describes force management as "an all-inclusive term for determining force requirements, allocating resources, and assessing the utilization of the resources."[47] The Navy describes it as "both a process and a system that converts national military strategy into personnel readiness."[48] In the Air Force, the term force management refers to "the entire life cycle of personnel" and includes "accession through retirement including readiness growth, development, and deployment."[49] These distinct differences between each service's description of human resources highlight the lack of a unifying perspective among the departments, even though they all have the same economic, career, education, and health factors affecting their human resources.

Additionally, while each service maintains its respective systems and processes for recruiting, accession and retention, leadership has issued very little, if any, public-facing strategic human capital guidance for their respective Services and chains of command. This point was identified in a 2001 GAO report, highlighting four areas in which military organizations have demonstrated significant performance gaps. They are as follows: "leadership, strategic human capital planning, retaining talent, and a results-oriented

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46 Oriana Pawlyk, "Air Force Misses New Pilot Goal Again as Service Pushes to Revolutionize Training," Military.com, February 18, 2020, https://www.military.com/daily-news/2020/02/18/air-force-misses-new-pilot-goal-again-service-pushes-revolutionize-training.html.

47 U.S. Army War College, *2015–2016 How the Army Runs: A Senior Leader Reference Handbook,* 2016, https://publications.armywarcollege.edu/pubs/3283.pdf, 18–24.

48 Naval Support Activity Southern potomac, "Total Force Manpower," April 2020, https://www.cnic.navy.mil/regions/ndw/installations/nsa_south_potomac/installations/nsf_indian_head/about/total_force_manpower.html.

49 Air Force Personnel Center, "About Us," accessed March 29, 2021, https://www.afpc.af.mil/About/.

culture."[50] Additionally, the GAO asserts this lack of understanding is apparent within the military's leadership and management.[51] The report was updated in 2019 to show that not only were no improvements made over nearly 20 years in response to the previous findings but there had also been a further decline in leadership's commitment to the previously identified issues. As a result, the GAO report moved the problem into the "high-risk" area.[52]

This preliminary research suggests a gap exists between human capital, captured in the academic literature, and the perception of human value in the military. As demonstrated by the military's chronic pilot manning problem, there is an apparent inability to fully leverage the value of human capital. On the one hand, the academic literature designed for private enterprises suggests a long-term focus on the value of human capital for a business's survival. On the other, defense requirements are held in check by fiscal cycles of budgetary constraints. This juxtaposition has driven the military to focus on only those processes within their short-term control.

This thesis seeks to address this gap between the value of human capital and military budgetary constraints by answering the following research question. By embracing a "human capital systems" approach, that incorporates economic and technological trends in an evolving strategic environment**, *how can the Air Force achieve an end-strength of 21,000 pilots by 2030?***

[50] U. S. Government Accountability Office, "High-Risk Series: Dedicated Leadership Needed to Address Limited Progress in Most High-Risk Areas," March 2021, https://www.gao.gov/products/gao-21-119sp.

[51] U. S. Government Accountability Office, "High-Risk Series: Dedicated Leadership Needed to Address Limited Progress in Most High-Risk Areas," 31.

[52] U. S. Government Accountability Office, 32.

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II. LITERATURE REVIEW

This Literature Review will cover five academic areas of interest that contributed to an understanding and analysis of military force structure and manning shortages in a period of great power competition. This work included a review of U.S. military manpower, strategic human capital management, human resource management in the military, recent and future trends (both in military technology and society and culture), and changing mental models with system dynamics.

A. REVIEW OF U.S. MILITARY MANPOWER

Millet's *For the Common Defense* provided a broad and deep historical overview of American wars from the early colonial period to 2012. He discusses the military force required to meet security objectives and speaks of the cost of human lives at the end of each conflict. Millet's research is a comprehensive, chronological survey of American military history that blends a discussion of strategic decision-making with operational and tactical details.

Gentile et al.'s "The Evolution of U.S. Military Policy from the Constitution to the Present" offers an insightful, four-volume reference that catalogs military and congressional decision-making, leading to significant policy changes throughout America's military's history. The authors' focus is primarily on Army force structure but with clear, general applicability for all services. They assert that the AVF was created due to President Lyndon Johnson's misuse of the draft during the Vietnam war.[53] Public opposition to the war and subsequent social unrest led to a re-examination of national security objectives and the military's manning policies. The transition to the AVF in 1973 brought into consideration a synthesis of opinion poll data, national security objectives, units required to meet those objectives, and financial data.[54] Both Millet and Gentile's

[53] Gentile, Linick, and Shurkin, Volume IV, 17.

[54] Gentile, Linick, and Shurkin, Volume IV, 151–172.

works highlighted the absence of a coherent military policy and how, over time, ideological debates and compromises could lead to changes in the force structure.[55]

B. STRATEGIC HUMAN CAPITAL MANAGEMENT

Human capital management has its roots in general management science. What started with Taylor and Fayol in the late 19th and early 20th centuries as scientific approaches to business management became human resource management when corporations began employing thousands of people. Witzel explains in a *History of Management Thought* how business managers developed an understanding of their workforce as a resource over time, which, when properly managed, could have long-standing strategic benefits for firms. While the principles of effective management existed long before Taylor and Fayol, the strategic implications of human resources were not recognized as a source of competitive advantage until the effects of globalization were fully realized in the 1970s.[56]

Characterized by a "whipsawing" effect that attempted to balance rapid employee turnover with high production output, the private sector experienced a crisis during an economic recession as post-World War II expansion slowed. Businesses suffered a departure of skilled labor as many World War II-era factory workers retired. As America's "greatest generation" exited the labor force, they were replaced by younger workers who lacked the previous generation's experience. This new, largely unskilled labor force initially produced substandard goods that simply could not compete with cheaper labor markets abroad.[57] Deming's *Out of the Crisis* became the "gold standard" for total quality management (although Deming never explicitly mentioned the term). It linked the quality

[55] Gentile, Linick, and Shurkin, Volume I, 4.

[56] Morgen Witzel, *A History of Management Thought* (Milton Park, Abingdon, Oxon ; Routledge, 2011), 39–47.

[57] Peter V. Marsden, *Social Trends in American Life: Findings from the General Social Survey Since 1972* (Princeton University Press, 2012), 315–318.

of goods and services to a range of stakeholders that included managing board members, business partners, the labor force, and customers.[58]

As human resource management became common business practice, economic theories began to influence many corporations.[59] With Schultz's *Investment in Human Capital: The Role of Education and Research*, business managers could now study the effects of human capital management on a population-wide scale. The author's work included three main characteristics that fundamentally shaped strategic management. First, he showed that countries without sufficient human capital could not manage physical (infrastructure) capital. Second, he demonstrated how real economic growth relies on equal increases in physical capital and human capital. Lastly, Schultz asserted that human capital is the most critical factor in a nation's economic and private business growth.[60]

Similarly, McDonald examined the defense sector's human capital and its relationship to the economy. He describes the "defense-growth" relationship as the relationship between defense allocations within the federal budget and the growth of the American economy.[61] Specifically, McDonald's research attempted to quantify the human capital a military member represents and how the value of that human capital contributes to the economy. Covering the years from 1954 to 2014, the author established a dynamic equilibrium model with the defense sector as an economic constraint and drew steady-state values from the period.[62] While many scholars debate how the decades-long Cold War and Global War on Terror have affected the American economy, McDonald's research focused primarily on whether the military expense resulted in a net positive effect.[63] The findings

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[58] W. Edwards Deming, *Out of the Crisis* (Cambridge, Mass: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1986), 5–7.

[59] Richard P. Rumelt, Dan Schendel, and David J. Teece, "Strategic Management and Economics," *Strategic Management Journal* 12, no. S2 (1991): 5–29, https://doi.org/10.1002/smj.4250121003.

[60] Theodore William Schultz, *Investment in Human Capital; the Role of Education and of Research* (New York: Free Press, 1970), 5–13.

[61] Bruce D. McDonald, "A Human Capital Model of the Defense-Growth Relationship: The Social Science Journal: Vol 0, No 0," accessed April 26, 2021, https://www.tandfonline.com/doi/abs/10.1016/j.soscij.2019.04.005.

[62] McDonald, 4.

[63] McDonald, 5.

showed how military force structure and its subsequent human capital input could positively and indirectly have a net positive effect. Directly, military skills and training offer a net benefit to the economy, and indirectly service members contribute to the DOD's ability to serve the nation.[64] Interestingly, a 2002 study by David Loughran indicated that most military members who leave the service opt for low-wage, industrial jobs regardless of labor market conditions.[65]

While McDonald's research shows a positive correlation between defense spending on personnel training and the health of the U.S. economy, this phenomenon is not universal. For a strategic competitor, researchers identified a negative correlation between defense spending and the economy in China. Zhao, Zhao, and Chen showed how the Chinese economy produced an opposite effect when examining defense spending with reductions in the Chinese military.[66] The study found that it needed to reduce defense allocations for China to grow its economy and increase budget spending for public sector education and health.[67] Although both studies examined defense spending, only McDonald's work focused on human capital investment. Today**,** the military's support of national security objectives is, as it has been in the past, a balancing act between economics, strategic threats, and political policies, whether at home or abroad. Strategic HCM is a process aimed at forecasting and balancing present needs with future demands.

A considerable portion of the academic research related to HCM in the military examined the manpower required to execute specific missions. Typically, force structure models are built around current or emerging national security threats, with contingency plans linked to scenarios or wargaming of potential conflicts. The following section describes the most recent studies related to the military's applications of human resource management.

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64 McDonald, 8.

65 David S. Loughran, *Wage Growth in the Civilian Careers of Military Retirees* (Santa Monica, CA: Rand, 2002), 39.

66 Liming Zhao, Liang Zhao, and Bing-Fu Chen, "The Interrelationship between Defence Spending, Public Expenditures and Economic Growth: Evidence from China," *Defence and Peace Economics* 28, no. 6 (November 2, 2017): 703–18, https://doi.org/10.1080/10242694.2015.1111603, 2.

67 Zhao, Zhao, and Chen, 4.

C. HUMAN RESOURCE MANAGEMENT IN THE MILITARY

In 2000, Taylor et al. presented one of the most prominent military studies of human resources focused on the aviation community. They suggested that the Air Force had recruited and trained an insufficient number of pilots during a decade of force reductions from 1990 to 1999.[68] The study found that fighter aircraft units experienced a loss rate exceeding 70 percent in 1997. Further, 25 percent of experienced pilots who had reached 15 years of service separated before retirement. Flying units would require 25 percent more flying hours, with increased operating and maintenance costs, to compensate for the loss of experienced pilots.

Finally, filling units with new, inexperienced pilots caused fully qualified pilots to fly more hours since they were needed to manage and train the inexperienced pilots.[69] The added hours for fully trained pilots increased their separation rate and required additional O&M allocations to cover the additional costs associated with flying more missions.[70] The study concluded that the Air Force needed to establish an active duty aviation community rotation with Guard and Reserve units to compensate for the pilot shortage. Additionally, the annual accession of fighter pilots should be limited to 330, of which 30 personnel would report to non-active-duty units.[71] When the Air Force incorporated the changes recommended in the study, they only exacerbated the problem by effectively reducing the number of pilots in Field Training Units (FTU), which in turn increased the number of hours flown per month by operational units.

A 2019 study on the relative cost-effectiveness of Air Force pilot retention versus accession provided essential background data for the use case presented later in this research. Mattock et al. examined costs associated with training and the costs of aviation incentives and retention bonuses to determine whether the incentives were high enough to

[68] Taylor, Moore, and Roll, 2.

[69] Taylor, Moore, and Roll, 14.

[70] Taylor, Moore, and Roll, 14.

[71] Taylor, Moore, and Roll, 35.

retain pilots in a competitive job market.[72] The study concluded that pilots remained in the Air Force longer and beyond 20 years of service when the aviation incentives were increased to $35,000 per year.[73] The study also showed that due to the cost of pilot training, which varies from $1.01 million for a C-17 pilot to approximately $10.9 million for an F-22 pilot, it is more cost-effective to increase career incentives than to increase accessions to sustain inventory. Even if training costs could be reduced to $1 million per pilot, a $45,000 aviation bonus per year would be required to keep fighter pilots after their initial 10-year service commitment to compete with future airline hiring demand.[74]

However, Mattock's research has several limitations. One of its limitations is that it focused primarily on fighter pilot incentives, even though fighter pilots only comprised 25 percent of the entire aviation community. Additionally, Mattock's research examined no other options for managing or retaining pilots. These options might have included cross-training pilots to fly additional aircraft during peacetime, incentivizing inter-service transfers, or pursuing enlisted pilot programs. It also fails to address options to reduce the cost of training or increase the use of unmanned vehicles to reduce manned fighter pilot missions over time.

D. RECENT AND FUTURE TRENDS

1. Recent and Future Trends in Military Technology

In addition to the literature on military force structure and human resources, previous research on future military technology offered insight into the technological trends that will "likely influence future military operations."[75] Andas's recent research highlighted software and hardware platforms in development by the defense industry.

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[72] Christopher Caraway, "A Looming Pilot Shortage: It Is Time to Revisit Regulations," *International Journal of Aviation, Aeronautics, and Aerospace* 7, no. 2 (January 1, 2020), https://doi.org/10.15394/ijaaa.2020.1470.

[73] Michael G. Mattock et al., "The Relative Cost-Effectiveness of Retaining Versus Accessing Air Force Pilots," March 27, 2019, https://www.rand.org/pubs/research_reports/RR2415.html, xi.

[74] Mattock et al., xvi.

[75] Harald Andas, "Emerging Technology Trends for Defence and Security," *Norwegian Defense Research Establishment*, April 2020, http://18.195.19.6/bitstream/handle/20.500.12242/2704/20-01050.pdf?sequence=1&isAllowed=y, 3.

According to Andas, a range of technology designed to improve loiter, monitoring, and response times are currently underway. In addition, he forecasts increased use of directed energy, hypersonic, and space-based platforms with offensive and defensive capabilities and their supporting C2 and C4I infrastructures. Also, Andas anticipates that future command infrastructure will incorporate predictive algorithm support for decision-making and foresees its increased use over the long term.[76] These technologies will include advanced robotics, autonomous systems, AI, and augmented reality technologies, which Andas predicts will facilitate manned-unmanned teaming to enable a single operator to control more than one unmanned vehicle.[77] Finally, he contends that such technologies will reduce manpower requirements in future warfare environments, although he makes no specific predictions of the rate at which technology will displace manpower.

In addition to Andas' research, Thornton and Miron's work suggests the future of warfare will be heavily influenced by a new international arms race that AI is expected to dominate.[78] They assert that while "NATO focuses on how to win battles, Russia focuses on how to win wars."[79] The strategic focus on winning future wars has guided the Russian military to redesign its approach to warfare completely. This redesign is centered on cyber warfare but completely automated through AI.[80]

According to the authors, the Russian military is leading the way in AI research and development. Evidence supporting Russia's military commitment to the growth of their AI can be seen in the employment of AI-enhanced mine-clearing systems like the Uran-6 and Uran-9 mine-clearing and Marker armored fighting vehicles in Syria.[81] In addition to the ground-based vehicles, Russia has also employed an AI-enhanced drone in the Sukhoi S-

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[76] Andas, 31.

[77] Andas, 14–16.

[78] Rod Thornton and Marina Miron, "Towards the 'Third Revolution in Military Affairs,'" *The RUSI Journal* 165, no. 3 (April 15, 2020): 12–21, https://doi.org/10.1080/03071847.2020.1765514.

[79] Thornton and Miron, 12.

[80] Thornton and Miron, 11.

[81] Thornton and Miron, 13.

70 and its air defense and ballistic missile systems.[82] Russia has demonstrated an unquestionable commitment to advancing this technology in its weapons systems.

Still, Russia's strategic commitment to "active defense" is aimed at using political and social division as a primary force multiplier. Russia intends to wage AI-enabled information and cyber warfare to defeat an adversary, not simply to disrupt or disable a network.[83] From the Russian perspective, AI can overload the information space with fake data in sufficient enough quantities to render the truth impossible to discern. The Russian military believes that cognitive warfare would involve a struggle for truth in this environment.[84] According to Thornton and Miron, the Russians believe such a war can be controlled to their advantage by using AI effectively.

In addition to Russia's example of the future conduct of cyber warfare, technology is driving other changes in military strategy. Directed energy weapons and anti-satellite missiles pose a viable, kinetic threat to the U.S. early warning and nuclear command and control (C2) satellites. Del Monte's research indicates that at least one nation may have already employed a space-based laser weapon system.[85] The author points to the U.S. refusal to sign the proposed 2008 Chinese-Russian treaty to prevent the deployment of weapons of mass destruction in space as an indicator of potential U.S. capability.[86]

However, there is no guarantee that the U.S will be able to maintain a monopoly on any offensive or defensive technology or innovation in the future.[87] The U.S. is expected to be challenged by a four-faced threat from counterterrorism, gray-zone or hybrid warfare, asymmetric or unconventional warfare (to include cyber warfare), and high-end

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[82] Thornton and Miron, 13.

[83] Thornton and Miron, 14.

[84] Thornton and Miron, 15.

[85] Louis A. Del Monte, *War at the Speed of Light: Directed-Energy Weapons and the Future of Twenty-First-Century Warfare* (U of Nebraska Press, 2021), 9.

[86] Louis A. Del Monte, *War at the Speed of Light*, 9.

[87] Raphael Cohen et al., *The Future of Warfare in 2030: Project Overview and Conclusions* (RAND Corporation, 2020), https://doi.org/10.7249/RR2849.1, 14.

conventional warfare with a peer or near-peer.[88] These threats suggest the U.S. must invest in a variety of technologies and capabilities to "renew its enduring advantages."[89] As the strategic environment continues to increase in complexity, domestic political and ideological divisions will contribute to competing narratives that further complicate America's ability to effectively respond to a wide array of threats.

2. Radical Changes in Society and Culture

In addition to the literature on warfighting trends, changes in the American population have contributed to the military's inability to recruit and retain talented personnel. According to a 2018 report by Spoehr and Handy, 71 percent of Americans between 17 and 24 are ineligible for military service. The researchers identified four main disqualifiers: health problems, physical fitness, education, and criminality.[90] Spoehr and Handy concluded with a plan that included recommendations for the executive branch, Congress, and local government support in finding a solution. But how did the country arrive at what Lieutenant General John Bednarek claims is a national security issue?[91]

Perhaps research by Janowitz can offer some insight. Janowitz claimed many people are uninformed by a larger vision of societal needs. When added to what Janowitz calls a "weakening court system," the distance between "judicial reasoning and popular moral beliefs" becomes significant.[92] Janowitz concluded by examining social controls intended to usher populations into conditions of "higher moral principles." He believes that American culture has always been guided by three essential themes from a sociologist's

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[88] Cohen et al., 37.

[89] Joseph Biden, "Interim National Security Strategic Guidance," The White House, March 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/03/interim-national-security-strategic-guidance/, 6.

[90] Thomas Spoehr, "The Looming National Security Crisis: Young Americans Unable to Serve in the Military," The Heritage Foundation, accessed March 10, 2021, https://www.heritage.org/defense/report/the-looming-national-security-crisis-young-americans-unable-serve-the-military.

[91] Spoehr.

[92] Morris Janowitz, *The Last Half-Century: Societal Change and Politics in America* (Chicago: University of Chicago Press, 1978), 118.

perspective: Protestant ideology, personal freedom, and individuality.[93] Janowitz's research on political and social constructs offers an elemental awareness of the structural reasons why so many Americans are ineligible for military service.

Similarly, Rosen identified a connection between social structures and strategic behaviors as they relate to the military.[94] First, Rosen examined how social structures affect how members of society treat each other. He discussed the notion that servicemembers, after repeated deployments and combat, become separated from the larger society psychologically. A government's ability to staff its military is affected by the "dominant social structures of the host society."[95] Rosen claimed the military's ability to perform its institutional functions is undergirded by the larger society, impacting its ability to wield offensive and defensive power.[96]

Similarly, Alperovitz makes a convincing argument that the social problems inherent in America's economic and political system negatively affect the population writ large, which likely has implications for recruitment and retention. Central to Alperovitz's argument is that systemic problems severely affect American society.[97] Shifts in the American population brought on by changes in demography have impacted American political views, and these political views have led to policy changes.[98] Moreover, the policy changes have been failing Americans in a way that contributes to radical changes in education, culture, and ultimately, society. As previously described by Forrester, this systemic quality manifests itself in ways that are difficult for people to comprehend and even more challenging to solve.

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93 Janowitz, 43.

94 Stephen Peter Rosen, "Military Effectiveness: Why Society Matters," *International Security* 19, no. 4 (1995): 5–31, https://doi.org/10.2307/2539118, 2.

95 Rosen, 25.

96 Rosen, 27.

97 Gar Alperovitz, *What Then Must We Do?: Straight Talk about the Next American Revolution* (Chelsea Green Publishing, 2013), 3.

98 Alperovitz, 4.

A quick update to Alperovitz's statistics suggests the problems he identified eight years ago have only gotten worse. Economically, the top one percent of Americans earned 10 percent of all income 45 years ago.[99] Currently, that group earns 20 percent of all income.[100] Slow wage growth has left most Americans without the means to achieve a decent standard of living.[101] Weekly earnings for average Americans have risen 3 percent in the last ten years when adjusted for compositional effects of COVID-19.[102] Further, Hispanics have become the largest ethnic minority group, surpassing African Americans by 6 percent in 2019.[103]

Moreover, the composition of the American family has changed. When measured in 1968, 7 percent of parents were unmarried, compared to 25 percent in 2017.[104] Of course, not all unmarried parents live in separate homes, but this number does indicate a shift in the population's view of marriage.[105] The incarceration rate has increased substantially, which has reduced the recruitment pool of military-aged males. For example, in 1968, the rate of incarcerated persons in the U.S. was 93 per 100,000; today, that number has grown to 655 per 100,000.[106] Further, according to Tikkanen and Abrams, among the world's wealthiest nations, the U.S. now ranks among the worst in "inequality, poverty, life expectancy, infant mortality, mental health, obesity, public spending as a percentage

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99 Steven K. Vogel, "The Regulatory Roots of Inequality in America," *Journal of Law and Political Economy* 1, no. 2 (2021), https://escholarship.org/uc/item/9zw2v8q8, 273.

100 Vogel, 274.

101 "The Pandemic's Effect on Measured Wage Growth," The White House, accessed May 28, 2021, https://www.whitehouse.gov/cea/blog/2021/04/19/the-pandemics-effect-on-measured-wage-growth/.

102 "Real Average Weekly Earnings Decreased 1.4 Percent for Year Ended April 2021 : The Economics Daily: U.S. Bureau of Labor Statistics," accessed May 28, 2021, https://www.bls.gov/opub/ted/2021/real-average-weekly-earnings-decreased-1-4-percent-for-year-ended-april-2021.htm.

103 William H. Frey, "The Nation Is Diversifying Even Faster than Predicted, According to New Census Data," *Brookings* (blog), July 1, 2020, https://www.brookings.edu/research/new-census-data-shows-the-nation-is-diversifying-even-faster-than-predicted/.

104 Alperovitz, 4.

105 Alperovitz, 4.

106 "Criminal Justice Facts," The Sentencing Project, 2020, https://www.sentencingproject.org/criminal-justice-facts/.

of GDP, the well-being of children, and overall environmental performance."[107] These previously discussed indicators reinforce Alperovtiz's claim that the issues facing Americans today require a systems approach to address.

Comprehensively, Janowitz, Rosen, and Alperovitz have contributed significantly to a central theme of this research: the American population's ability to support a growing military force is impaired. Janowitz claims that the U.S., although wealthy, has inherent problems within its societal structures. Rosen identified the link between the societal structure and its influence on the military's ability to perform its core functions. Alperovitz identified the need to view these problems from a system's perspective. The literature suggests globalization paired with economic, political, and demographic shifts have likely led to a reconsideration of traditional American values and may influence America's ability to govern and staff a military.

E. CHANGING MENTAL MODELS WITH SYSTEM DYNAMICS

Jay Forrester has often been called the father of System Dynamics.[108] In his seminal work, *Principles of Systems*, he established a method for modeling systems.[109] Forrester's research illustrated how to model a system's behaviors by using causal loop diagrams and feedback to represent the paths for material and information. His work is widely referenced as it presents itself within reach of those unfamiliar with computer systems modeling by providing easy-to-understand inventory and sales examples. Also, in *Modeling for Learning Organizations*, Forrester expressed his philosophy on system dynamics modeling when used for policies, decision-making, and information sources.[110] Further, it included Forrester's recommendations for more practical education, an idea

107 "U.S. Health Care from a Global Perspective, 2019: Higher Spending, Worse Outcomes?," accessed May 20, 2021, https://doi.org/10.26099/7avy-fc29.

108 "Jay Wright Forrester | Biography, Inventions, & Facts," Encyclopedia Britannica, accessed May 20, 2021, https://www.britannica.com/biography/Jay-Wright-Forrester.

109 Jay Wright Forrester, *Principles of Systems*, 2nd prel. ed. (Wright-Allen Press, 1971), 2–9.

110 John D. W. Morecroft and John Sterman, *Modeling for Learning Organizations*, System Dynamics Series (Portland, Or: Productivity Press, 1994), 86.

Forrester attributed to Nancy Roberts.[111] In this way, Forrester's work (and system dynamics, generally) contribute to a more robust examination of human capital within the management sciences.

In addition to Forrester, scholars like Churchman and Sterman have made substantial contributions to system dynamics and have demonstrated its applicability to government policy, including military force structure. A critical aspect of system dynamics is that it explicitly accounts for interconnected system elements whose behavior is often the result of nonlinear effects. As previously mentioned, many of today's social, economic, and national security issues, including force structure, resulting from a complex system of competing interests from stakeholders representing local governments, private corporations, and various social interests.[112] This context presents decision-makers with nonlinear challenges, which are difficult for traditional mental models to capture. In other words, traditional scientific approaches that employ an events-driven, reductionist approach[113] to problem-solving simply will not suffice.

Churchman provided a practical approach to systems thinking for scientific management. He encouraged readers to view complex problems in the context of systems.[114] Following Churchman's practical approach to scientific management, Sterman's *Business Dynamics* contributed methods to move from practical approaches in management to specific tools and processes for strategic policy creation.

System dynamics offers qualitative and quantitative reasoning that can support decision-making through increased forecasting of unpredictable outcomes that emerge from complex systems. This perspective, and the resulting modeling approach, are helpful

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111 Morecroft and Sterman, 81.

112 John Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World with CD-ROM* (McGraw-Hill Education, 2003), xvii.

113 From *The SAGE Encyclopedia of Business and Ethics Society*, reductionsim is the view that a whole is nothing but the sum of its parts. Whenever one level, domain, or whole is analyzed as nothing more than another, it is said to be reduced to that other. The whole does not impart meaning to its parts; rather, the parts are the meaning of the whole.

114 C. West Churchman, *The Systems Approach*, [2nd ed.]. Rev. and updated, first Laurel Printing., A Laurel Book (New York, N.Y: Dell PubCo, 1983), 41–44.

for decision-makers because, as Forrester expounds, all decisions are made within feedback loops.[115] Feedback loops are described by a process beginning with a decision, which controls an action. That action, in turn, alters the state of the system, characterized by a stock or state variable and its associated net rate of change. These rates of change are generally determined by non-linear feedback mechanisms that can be conceptualized by cause and effect relationships of independent and dependent variables with loops of system behavior. These loops display positive, reinforcing, or negative, balancing, behavior within the system.[116]

Perhaps the most beneficial aspect of system dynamics is the embodiment of "theories of action" captured in single-loop and double-loop learning. Argyris describes single-loop learning with an example of a thermostat which "learns" when the current temperature is above or below the desired temperature and can turn the system on or off.[117] Double-loop learning allows a second and more fundamental inquiry about the rules and policies which govern the system.[118] Furthermore, Argyris claims that while organizations are good at single-loop learning, it is the underlying management theory that created the problem, to begin with, and is symbolic of deficient mental models.[119]

In addition to Forrester's system dynamics foundation and Argyris' single and double-loop learning, Tversky and Kahneman's research into decision-making under conditions of uncertainty, the use of heuristics, and associated judgmental biases underscore the potential flaws in our mental models. Models based on heuristics, or overly simplistic principles, although helpful, harbor biases and often lead to grave errors in judgment and policy.[120] These errors are caused by cognitive biases that present themselves to novices and experts alike and require more advanced methods for

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[115] Forrester, *Principles of Systems*, 6.

[116] Forrester, 7.

[117] Chris Argyris, "Double Loop Learning in Organizations," *Harvard Business Review*, September 1, 1977, https://hbr.org/1977/09/double-loop-learning-in-organizations.

[118] Argyris.

[119] Argyris.

[120] Amos Tversky and Daniel Kahneman, "Judgment under Uncertainty: Heuristics and Biases," *Science* 185, no. 4157 (September 27, 1974): 1124–31, https://doi.org/10.1126/science.185.4157.1124, 1.

understanding system complexities.[121] System dynamics offers a methodology to allow leaders and managers to gain an enhanced understanding of the non-linearities that play a role in complex systems and to then adjust their mental models.

As Tversky and Kahneman have explained, mental models, based on intuitive judgments, are often the result of well-intentioned managers who work in specialized areas within the system and unwittingly focus on short-term problems trying to affect long-term change.[122] But these models often fail to account for nonlinear feedback that can counteract newly implemented policies and worsen existing problems. This phenomenon was previously captured by Taylor's "Air Force Pilot Shortage" study.

[121] Tversky and Kahneman, 9.

[122] Tversky and Kahneman, 14.

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III. METHODOLOGY

This work uses an exploratory research methodology that includes system dynamics modeling to address a specific human capital concern for the Air Force. The Air Force pilot manning system was selected because it is arguably the most expensive military community in cost per capita and represents significant value in human capital.[123] This thesis incorporates strategic, economic, and technological trends with qualitative and quantitative data to develop the system dynamics model.

A brief description of system dynamics modeling, initial conceptualization with causal loop diagrams (CLD), and the model construction are included. The model includes a dashboard, or user "Interface," to aid in evaluating the problem over a simulated run of 30 years and to thereby inform policy and development that could achieve desired pilot manning goals. Simulations were run comparing different strategic approaches aimed at closing the manning shortfall. Findings are included, along with recommendations for further research.

[123] Mattock et al., "The Relative Cost-Effectiveness of Retaining Versus Accessing Air Force Pilots," 16.

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IV. USE OF MODELING

A. INTRODUCTION

As previously discussed in the literature review, system dynamics offers a methodology for leaders and managers to model complex systems that are producing problematic behavior. This approach can provide insight into the systemic failure of the Air Force to meet its pilot manning requirements. Fundamentally, Air Force human capital management consists of a complex man, train, and equip system of systems with a variety of agents, policies, delays, and resource constraints that provide non-linear feedback resulting in non-intuitive and often problematic behavior outcome over an extended time horizon.

A system dynamics model is intended to address an endogenous system that is resulting in problematic behavioral outcomes. The model is bounded arbitrarily so that the system structure ideally includes only the essential underlying dynamics required to identify the source of the problem. System dynamics models use differential equations to determine the net rates of change in units per time (referred to as "flows") for accumulations (referred to as "stocks") of any measurable tangible or intangible units. These accumulations represent the state of the system at any given time.[124] Mathematically, flows represent differentiation, and stocks represent integration, and the system's behavior changes as a result of various feedback structures within the system.

Rate equations are generally non-linear functions of exogenous, constant, and state variables that, together with delays, data, and feedback inherent in the system's structure, result in the system's behavioral outcomes over the course of the simulation's run. Traditionally, system dynamics models are validated by comparing graphs of actual system outcomes over a fixed period of time from time t_0 to t_n to a simulation initiated with actual

[124] Norman Wayne Porter, "The Value of System Dynamics Modeling in Policy Analytics and Planning," in *Policy Analytics, Modelling, and Informatics: Innovative Tools for Solving Complex Social Problems*, ed. J Ramon Gil-Garcia, Theresa A. Pardo, and Luis F. Luna-Reyes, Public Administration and Information Technology (Cham: Springer International Publishing, 2018), 123. https://doi.org/10.1007/978-3-319-61762-6_6, 123.

data at time t_0 and run over the same time period t_0 to time t_n. If the model's simulated outcome is a near enough fit to the actual trend of the system, the model's structure is validated. Often, however, system dynamics modeling is used to evaluate proscribed changes in policies intended to produce a more desirable outcome when run over an extended time horizon into the future. In this case, the model cannot be thus validated since the policies have not yet been implemented, and there are assumptions made regarding future conditions. In this case, "validation" of the model's fit is based largely on subject matter expert input into the system's structure, assumptions, and outcomes.[125]

B. CONCEPTUALIZATION

The first step in using this modeling approach is to develop a causal loop diagram (CLD). Independent and dependent variables are connected with arrows to demonstrate a relationship. These cause-and-effect relationships are denoted with positive or negative polarity. The polarity indicates whether the relationship between an independent and its linked dependent variables is positive or negative. Positive feedback reinforces change, while negative feedback balances change.[126] Positive feedback is similar to a positive correlation. When an independent variable increases (or decreases), the corresponding dependent variable experiences an increase (or decrease). Negative feedback is much like a negative or inverse correlation. When an independent variable increases (or decreases), the corresponding dependent variable decreases (or increases). To determine whether a loop is balancing or reinforcing, the negative polarity links in the loop are counted. If there are no negative links or an even number of negative polarity links, the loop is reinforcing and labeled with the loop identifier "R." If there are an odd number of negative links in the loop, it is balancing and labeled with a "B."[127]

[125] Porter, "The Value of System Dynamics Modeling in Policy Analytics and Planning," 123.

[126] Porter, 124.

[127] Porter, 124.

The Air Force Personnel Center (AFPC) uses many systems to recruit, assess, train, separate, retain, and retire its service members. AFPC works conjointly with Air Education and Training Command to identify vacant positions in flying units and select candidates to fill them. Air Force managers respond to vacancies within the system by creating a demand signal that often results in unintended consequences and costly outcomes over time. In addition, manning policies change in response to nearly every manning shortfall since Congress adjusts the military end strength through a planning and budgetary process annually. The current system uses the United States Air Force Academy and over 200 Reserve Officer Training Corps units on college campuses as commissioning platforms for Air Force officers and pilot candidates, augmented with inter-service transfers from within the DOD. After initial officer selection, pilot candidates begin an approximate three-year training process involving various personnel actions, including reassignments and reclassifications into various specialties. Despite decades of policy changes aimed at addressing recurring pilot manning shortfalls, the service has been unable to meet fluctuating pilot end-strength requirements.

The arrows drawn in the CLD in Figure 1 indicate positive and negative "causal links" between independent and dependent variables within the Air Force Pilot Manning System. Three causal loops within the Air Force's human resources system are labeled with loop identifiers indicating whether the loop's behavior is reinforcing (R) or balancing (B): Manned Pilot Demand; Unmanned Pilot Demand; and, Recruiting. These loops are influenced by various recruiting, retention, and separation causal relationships. According to the current Air Force management philosophy, after pilots are assigned to their operational units, the various aviation communities are assigned management teams based on aircraft type/weapon system. For example, once fighter pilots are assigned to a unit, they are managed separately from airlift or reconnaissance aircraft pilots. The same management philosophy applies to bomber-, airlift-, rescue-, and unmanned-aircraft pilots.

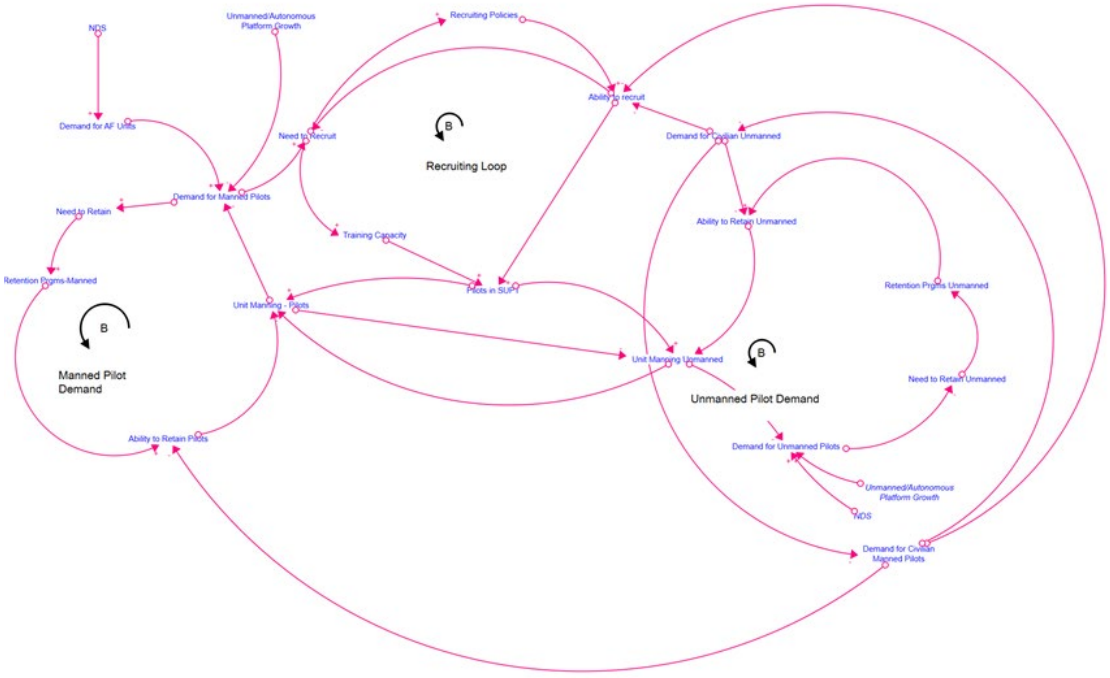

Figure 1. Air Force Pilot Manning System CLD (All Figures Herein Created Using ISEE System Stella Architect)

C. DATA SOURCES

The system dynamics model developed for this research was built using only publicly available, open-source data as reported by the Air Force Personnel Center (AFPC), RAND Corporation (RAND), the GAO, and various defense news outlets. Additionally, the model assumes a steady-state retention profile without imposed stop-loss or wartime restrictions on recruiting and retention policies. In order to analyze the total impact of policy changes over time, the model's simulation was designed to run for 28 years instead of the ten years cited in the research question. Some of these policy changes may only produce measurable effects or unforeseen consequences long after the ten-year window to achieve the desired manning.

Manned aircraft pilot manning was initialized to be 10,900, while unmanned aircraft pilot manning was initialized at 1,900. These figures were reported for Regular Air

Force (RegAF) active-duty pilots in 2018.[128] With only publicly available data, the model assumed a target goal of 21,000 based on the 2021 fiscal year budget request.[129] Additionally, the model uses the Air Force's 2019 end strength of 348,000 personnel with an associated 18 percent replenishment rate. Officer accessions data was compiled from the Reserve Officer Training Corps (ROTC), the United States Air Force Academy (USAFA),[130] and the Air Education and Training Command's (AETC) Officer Training School (OTS).[131] The GAO reported an average pilot loss rate of 8.78 percent (i.e., eight percent of the pilots leave the Air force annually). Additionally, the Air Force reports an attrition rate of 15 percent for the unmanned aircraft pilot training pipeline. The service has cited a failure to prescreen candidates for training as the cause for an attrition rate three times higher than manned aircraft pilot training platform.

The GAO identified a strong correlation between the civilian unemployment rate and "high quality enlisted" recruiting for the armed services.[132] Additionally, while it is the case that retention declines as the unemployment rate decreases, this correlation appears not to be as responsive as recruiting. This response difference between the numbers recruited and the numbers retained is likely due to varying delays associated with the net flows of each stock: current military members are already employed, and recruits are not. Thus, any decreases in the unemployment rate would have a more immediate (reduction) effect on the accession of recruits than on the separation of military members with contractual service commitments. Based on the strength of this correlation reported by the GAO, the model reflects changes in the unemployment rate as it influences recruiting. The

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128 Robbert et al., 6.

129 Honorable Shon J Manasco, "Fiscal Year 2021 Budget Request For Military Readiness," March 3, 2020, https://www.congress.gov/116/meeting/house/110633/witnesses/HHRG-116-AS03-TTF-WilsonS-20200303.pdf, 3.

130 "United States Air Force Academy - Profile, Rankings and Data | U.S. News Best Colleges," accessed May 19, 2021, https://www.usnews.com/best-colleges/united-states-air-force-academy-1369.

131 Air Education and Training Command, "AETC Demographic Snapshot," 2020, https://www.aetc.af.mil/Portals/88/Documents/Snapshot/AETC%20Snapshot%20FY20%20April%207%202021.pdf.

132 U. S. Government Accountability Office, "Military Personnel: Collecting Additional Data Could Enhance Pilot Retention Efforts," U. S. Government Accountability Office, June 2018, https://www.gao.gov/products/GAO-18-439.

model forecasts the future unemployment rate as a normal distribution, assuming employment trends over the next 30 years will largely resemble those of the last 30 years. Additionally, the global pandemic caused by COVID-19 is reflected in the unemployment rate trend, with a peak rate of 14.8 percent in April 2020.[133]

The model also assumes that commercial unmanned pilot demand will grow from less than 1,000 in 2018 to more than 60,000 by 2036.[134] The first unmanned large-body platforms are expected to be in service by 2025 in remote areas for specific applications such as short-haul cargo and passenger services.[135] As time goes by, the commercial aviation industry is expected to reduce its reliance on manned pilots to save about $35 billion per year. This shift in platform use equates to roughly $3 billion in savings for each major airline in an industry plagued by extreme competition, regulatory costs, and tight operating margins.[136]

The Defense Advanced Research Projects Agency recently hosted a competition between a human F-16 pilot and an AI computer developed by Heron Systems in a simulated dogfight. The AI computer's simulated aircraft beat the human pilot's simulated aircraft in every single round without the human scoring a single hit on the computer's aircraft. This work by DARPA is part of a long-running effort to increase confidence in autonomous systems in dogfighting scenarios that could result in a reduction in reliance on human pilots overall. DARPA's work assumes that over the next 10–15 years, reliance on manned aircraft platforms will decrease as unmanned platform use increases. Both an increase in commercial unmanned aircraft pilot hiring and DARPA's forecast of manned-unmanned platform parity are captured in the model using the term "The Singularity

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[133] Gene Falk et al., "Unemployment Rates During the COVID-19 Pandemic: In Brief," *Congressional Research Service*, January 2021, 16, https://fas.org/sgp/crs/misc/R46554.pdf, 1–4.

[134] U. S. Government Accountability Office, "Unmanned Aerial Systems: Air Force Should Take Additional Steps to Improve Aircrew Staffing and Support," U. S. Government Accountability Office, June 2020, https://www.gao.gov/products/gao-20-320.

[135] Philip E. Ross, "When Will We Have Unmanned Commercial Airliners? - IEEE Spectrum," IEEE Spectrum: Technology, Engineering, and Science News, accessed August 30, 2020, https://spectrum.ieee.org/aerospace/aviation/when-will-we-have-unmanned-commercial-airliners.

[136] U.S. Department of Transportation, "Unmanned Aircraft System (UAS) Service Demand 2015 - 2035," Technical Report, September 2013, https://fas.org/irp/program/collect/service.pdf, 59.

Effect." When activated in the model, it induces a nonlinear decrease of manned systems with an equal but opposite increase in unmanned systems intended to reach parity by 2035.[137]

D. AIR FORCE PILOT MANNING MODEL DEVELOPMENT

This research involved creating a simplified system dynamics model of the USAF pilot population with both "Manned Pilot Stock: and "Unmanned Pilot Stock." Other stocks used in the model are the "USAFA/ROTC," the "Total USAF Manning," and "Pilot Training." Pilot Candidates flow out of the USAFA/ROTC stock and flow into the Pilot Training stock. The Total USAF Manning stock represents that portion of the Air Force population not currently serving as pilots. Of note, Annual Lat Transfers to Manned Pilot Candidates flow out of the Total USAF Manning stock and into the Pilot Training stock. Circular converters represent various values that contribute directly or indirectly to the rate equations of each inflow and outflow (depicted as valves).

The model was structured in this way for several reasons. First, manned and unmanned platforms share pilots during times of critical manning shortages and increased operational tempos.[138] Second, unmanned and autonomous platforms' long-term strategic effects will increase over time while manned platforms will decrease.[139] This prediction is captured by a "The Singularity Effect" converter and is discussed further in the Data Analysis section of this paper.

According to a recent GAO report, the Air Force does not track the overall progress of accessing and retaining its remotely piloted aircraft (RPA) pilots to meet deployment goals.[140] Moreover, pilots move from the manned aircraft community to the unmanned aircraft community and vice-versa at varying rates, which have not been closely managed

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[137] Justin Jaussi and Herbert Hoffmann, "Manned Versus Unmanned Aircraft Accidents, Including Causation and Rates," *International Journal of Aviation, Aeronautics, and Aerospace* 5, no. 4 (January 1, 2018), https://doi.org/10.15394/ijaaa.2018.1262, 3.

[138] U. S. Government Accountability Office, "Unmanned Aerial Systems."

[139] Cohen et al., *The Future of Warfare in 2030*, 20.

[140] U. S. Government Accountability Office, "High-Risk Series," 4.

over the last ten years.[141] This research's simplified system dynamics model attempts to capture this flow between the stocks with estimates based on the manned and unmanned training dropout rates. In 2018, the Air Force commissioned RAND to conduct a study on the feasibility of allowing enlisted members into the pilot corps. The study recommended the Air Force adjust policy, allowing limited, infrequent pilot accessions from among the enlisted population and lateral transfers from other services, starting in 2021. The system dynamics model shown in Figure 3 incorporates these policy options.

The Air Force initially built the unmanned career field using manned pilots before establishing the RPA specialty. Approximately 42 percent of remotely piloted aircraft are currently flown by pilots qualified for manned aircraft and temporarily assigned to fly unmanned aircraft. On the other hand, about 17 percent of manned aircraft pilots came from the RPA community.[142] This imbalance in manned versus unmanned aircraft pilots was an essential element of the research design for this model. The model moves pilots between unmanned and manned platforms. It illustrates how the Air Force may prepare for the gradual decrease of manned platform utilization and the alternative increase of unmanned platforms. A U.S Department of Transportation report with research by the Volpe Center predicts that unmanned missions will exceed manned missions by 2035.[143] Using this prediction as a guide, the model simulates manned and unmanned parity as the Air Force moves to 21,000 pilots over the next ten years. The model is shown in Figure 3.

[141] Erik D Jorgensen, "Optimizing the Remotely Piloted Aircraft Pilot Career Field," January 2021, 42.

[142] U. S. Government Accountability Office, "Unmanned Aerial Systems," 7.

[143] U.S. Department of Transportation, "Unmanned Aircraft System (UAS) Service Demand 2015 - 2035," 4.

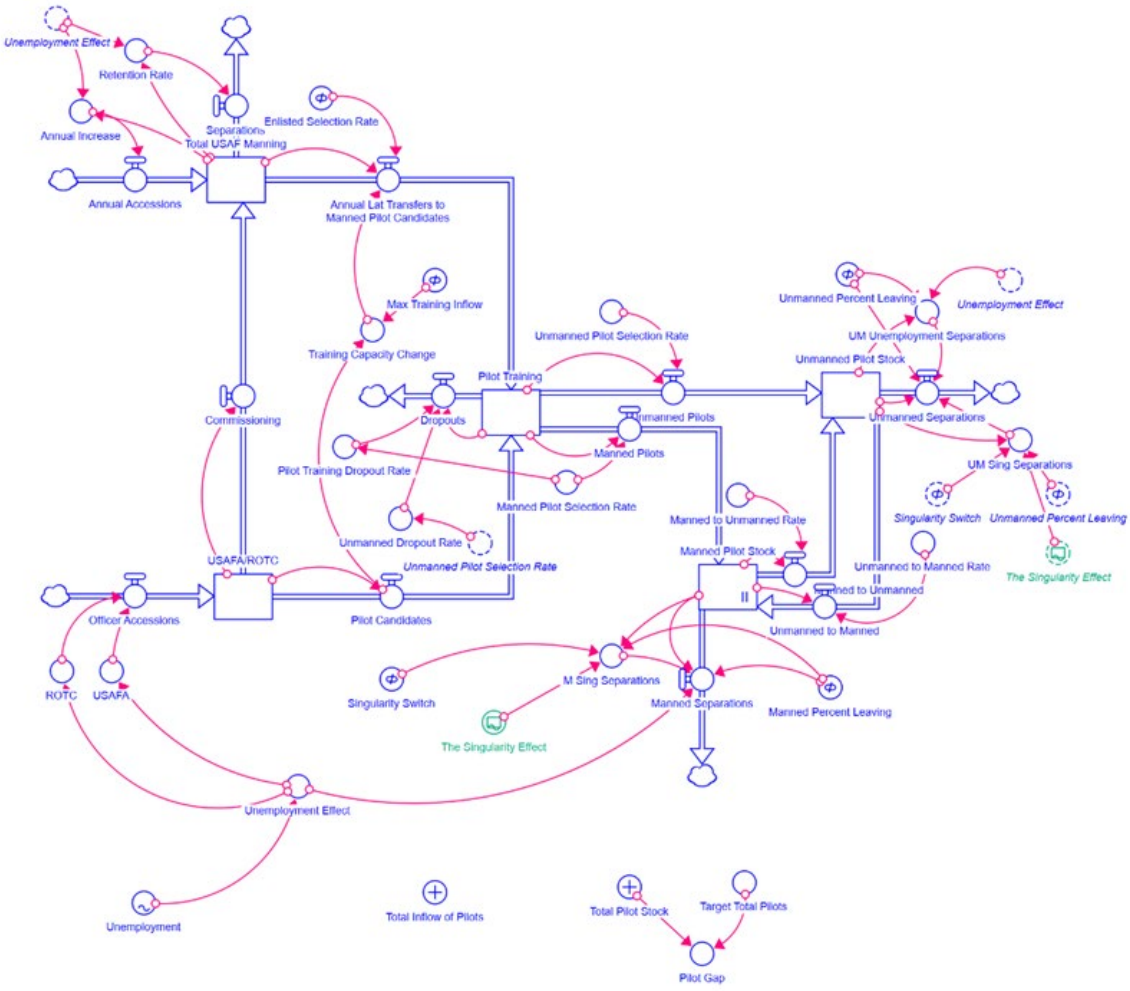

Figure 2. Air Force Manned-Unmanned Pilot System

E. MODEL OUTCOMES

In the three years since the Air Force Secretary's 2018 call to grow the force by 74 flying units,[144] the Air Force has not achieved any meaningful change with its current policies.[145] The few retention policy changes, such as a $35,000 increase in the aviation bonus and variable extension options for pilots, were not enough to stop 200 pilots from

[144] Secretary of the Air Force Public Affairs, "The Air Force We Need: 386 Operational Squadrons," U.S. Air Force, September 17, 2018, https://www.af.mil/News/Article-Display/Article/1635070/the-air-force-we-need-386-operational-squadrons/.

[145] Tobias Switzer, "The Air Force Pilot Retention Crisis Is Not Over," War on the Rocks, October 2020, https://warontherocks.com/2020/10/the-air-force-pilot-retention-crisis-is-not-over/.

leaving the service in the last two years. Even though manning figures for 2021 have not yet been collected, the model shows a total inflow of 9 percent of the total pilot stock, with a total outflow of 12.5 percent, a 3.5 percent net outflow in 2021. This outflow includes a nearly stable 8.78 percent loss rate after considering dropouts from the manned and unmanned pilot training pipelines. It is used for the duration of the model's run in Strategic Approach 1. The Air Force Manned-Unmanned Pilot System model was run to evaluate three different strategic approaches to achieving the desired pilot manning end-strength, as cited in the research question. These three strategic approaches are discussed below.

a. Strategic Approach 1

The first strategic approach implemented in the model aims to mirror current accessions, retention, and transfers between communities. These options most closely resembled the current state of the existing USAF pilot manning system. Therefore, the Unemployment Effect converter was enabled. In contrast, "The Singularity Effect" converter that introduced a speculative nonlinear decrease in manned aircraft use matched by an equal but opposite increase in unmanned aircraft use over time was not selected in Strategic Approach 1.

The first strategic approach for the Air Force analyzed with the system dynamics model is to implement a policy that directly affects the retention rate. Based on unemployment rate predictions, and despite high AvB, other compensation measures must be considered to incentivize pilots to continue their service. For example, offering more flexible service extensions associated with incentive pays and better assignment selection. This recommendation to target the retention rate directly with incentives is supported by the 2016 RAND study that showed significantly increased airline salaries were strongly correlated to an Air Force pilot's decision to stay or leave the service.[146] The Air Force can do this by offering more flexible term limits associated with lucrative aviation incentive pays (AvIP), and aviation bonus (AvB) incentive pays, better assignment selection, and possibly decreased operational tempo. Based on unemployment rate predictions and

[146] Michael G. Mattock et al., "Retaining U.S. Air Force Pilots When the Civilian Demand for Pilots Is Growing," July 12, 2016, https://www.rand.org/pubs/research_reports/RR1455.html.

despite high AvB, other compensation measures must be considered to incentivize pilots to continue their service. Additionally, exit interviews conducted in Taylor's "Air Force Pilot Shortage" study showed that most pilots who separated before they were retirement-eligible did so because of higher salaries and a diminishing amount of time spent in the cockpit due to increased administrative duties.[147]

Since the Air Force implemented AvIP and the AvB, it has significantly increased the costs of maintaining a more senior force. Still, it has found a simple way of increasing its pilots' experience. According to a 2019 RAND study in which unmanned pilots are excluded entirely, AvB increased pilot retention and ultimately human capital over an expanded accession pipeline. The pilot force is more experienced and senior at an average AvB of $100,00. Moreover, the per-pilot training cost decreases when the overall AvB cost is nonlinear, yielding a reduced cost per capita when the total AvB is higher and a higher cost per capita when the AvB is lower. Currently, the Air Force does not have enough data to draw a significant correlation between the AvB and the retention rate, so it prefers to examine retention related to commercial airline hiring rates.[148] Figure 3 shows the options selected in the dashboard, which most closely represent the system's current state as modeled.

[147] Taylor, Moore, and Roll, "The Air Force Pilot Shortage," 8–13.

[148] Michael G. Mattock et al., "Retaining U.S. Air Force Pilots When the Civilian Demand for Pilots Is Growing," July 12, 2016, https://www.rand.org/pubs/research_reports/RR1455.html, 16.

Figure 3. Strategic Approach 1

b. Strategic Approach 2

The second strategic approach introduces increased unmanned aircraft use into the system and raises the Unmanned Pilot Selection rate from the Pilot Training Stock to 30 percent. This approach has two benefits: it addresses the short-term RPA platform attrition rate and continues the Air Force's RPA community development priorities.[149] In this approach, the Pilot Training capacity must be expanded to 1,700 trainees per year.

[149] U.S. Air Force, "United States Air Force Unmanned Aircraft Systems Flight Plan 2009–2047," n.d., https://fas.org/irp/program/collect/uas_2009.pdf.

Additionally, this approach requires the transfer of pilots from the Unmanned Pilot Stock to the Manned Pilot Stock to be reduced to zero. Further, it requires a 10 percent increase in manned pilot transfers to the unmanned community with an 18 percent increase in enlisted and inter-service transfers to the Manned Pilot Stock per year. If all of the above policy changes were implemented, the modeling suggests the Air Force could close the manning gap by 2032. The dashboard controls are shown in Figure 4. Note the scale change on the x-axis in the Active Pilots graph on the left. Although the service does not reach the manning goal by the expiry date, this approach was intended to evaluate the minimum policy actions the Air Force must take to reach 21,000 pilots without pursuing other wartime, non-steady-state options that were beyond the scope of this research. Figure 4 highlights the increase from Manned to Unmanned transfers and the increase in Pilot Training candidates.

Figure 4. Strategic Approach 2

c. Strategic Approach 3

The final approach effectively shifted the Air Force's pilot manning from its current negative balance to the demand required by the NDS deadline. If the Air Force can increase Pilot Training capacity to 1,750 and decrease their pilot loss rates to 5 percent through a combination of increased AvIP and AvB and various other compensatory policies, the simulation showed the service could reach 20,500 pilots by 2030. The 5 percent loss rate may seem like an unreachable policy goal; however, it is essential to remember the Navy

reached this rate in 2013.[150] Only by decreasing the reliance on manned aircraft can the Air Force achieve parity between the manned and unmanned platforms and reach its stated goal of 21,000 pilots by 2030. The selected dashboard options and resulting charts are shown in Figure 5.

Figure 5. Strategic Approach 3

150 U. S. Government Accountability Office, "Military Personnel: Collecting Additional Data Could Enhance Pilot Retention Efforts."

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V. FINDINGS

In the Strategic Approach 1 model, which reflects the current Air Force Manned-Unmanned Pilot System, the Air Force adds pilots to its force at a rate of 2 percent per year and loses just over 8 percent on average per year. With a 2 percent inflow and an 8 percent outflow, the Air Force will continue to lose pilots over time. As constructed, the Pilot Training stock has a capacity of 1,300 students per year. Any attempt to increase the inflow rates into the Manned Pilot Stock or the Unmanned Pilot Stock was constrained by this capacity limit in the Pilot Training stock. Since the service has shown an inability to reduce the loss rate, the Air Force should increase capacity at the initial pilot training school in addition to increasing incentive pay. The first strategic approach most closely represents the current policies to solve the pilot manning problem. This constraint suggests that the Air Force may be reluctant to increase pilot training accessions through inter-service or enlisted transfers if that would result in fewer opportunities for USAFA and ROTC candidates.

The first strategic approach indicated a good fit of the model's structure with actual performance graphs of the Air Force's current policy options concerning accessions, transfers, and loss rates. The model mirrors the current pilot manning levels in manned and unmanned communities when these options are selected and run. The model indicated these options could reduce the shortfall but could not wholly eliminate it. Further, these options suggest that the pilot manning shortages will likely continue with only minor fluctuations if the Air Force takes no other action.

In the Strategic Approach 2 model, the Air Force Manned-Unmanned Pilot System exhibits a shift in loop dominance that results in S-shaped growth as the Manned and Unmanned Pilot Socks move toward parity by 2035. The Pilot Training capacity in Strategic Approach 2 was increased to 1,700 per year. Lateral transfers from other services or the USAF enlisted communities into Pilot Training were 299 per year. Finally, transfers from the Manned Pilot Stock to the Unmanned Pilot Stock were increased to 10 percent of the Unmanned Pilot Stock annually. As a result, the inflow of pilots was increased from 1,300 per year to 1,550 per year after initialization. The Manned and Unmanned Pilot

stocks grew to 8,280 and 8,480 respectively by 2033. After which, the Manned Pilot Stock increased to 10,000, while the Unmanned Pilot Stock gradually decreased to 7,710 by 2048. In the dashboard, the Manned Pilot Selection Rate and Unmanned Pilot Selection Rate simulated a policy directive to send 69.9 percent of the candidates to the Manned Pilot Stock and the remaining 29.1 percent to the Unmanned Pilot Stock. Total Air Force manning increased to 365,000 by 2030 and continued to grow to 416,000 by 2049. Additionally, manned pilot separations increased during the first five years to 1,000 per year but gradually declined to 578 per year in 2039.

Additionally, there has been no change to the current 8.78 percent loss rate after factoring in training dropouts. According to the model, despite all current policy options, the Air Force will fall short of meeting the demand for 21,000 pilots by 2030 (Figure 5-graph). However, if the Air Force could increase the training pipeline to 1,700 candidates per year and decrease the loss rate through various policy options to 5 percent by incorporating the manned/unmanned parity of technological growth over time, the model suggests the Air Force could potentially reach its pilot manning goal by 2030.

The options selected in Strategic Approach 3 represented the most extreme policy options. In addition to those described in the second strategic approach, Strategic Approach 3 modeled an evenly split, 50 percent -50 percent selection rate for the Manned Pilot Stock and the Unmanned Pilot Stock. Additionally, the annual Pilot Training Stock's capacity was increased to 1,750 candidates per year and enlisted, and inter-service transfers were raised to 348 annually. With these options selected, the Manned Pilot Stock decreases only slightly from 10,900 at initialization to 10,200 by 2030. The Unmanned Pilot Stock, however, increases rapidly from 1,900 at initialization to 10,910 by 2030. These figures bring the combined totals in the Manned Pilot Stock and the Unmanned Pilot Stock to the Air Force's desired end strength goal by the expiry date. After 2030, both stocks continue to increase slightly every year until reaching 11,500 and 13,100 in the Manned Pilot Stock and Unmanned Pilot Stock, respectively, by 2048. Total Air Force manning increased to 375,000 by 2030 and continued to grow to 446,000 by 2049.

VI. CONCLUSION, RECOMMENDATIONS, AND FURTHER RESEARCH

This exploratory research reviewed previous academic work in human capital management in the context of military force structure, the current strategic environment, and recent technological and cultural trends that impact military human resource management. Warfare-centric human capital management was examined from a strategic design perspective to explore the potential value of understanding and employing human resources and technology more effectively in the military. System dynamics concepts and modeling were used to analyze strategic human capital management approaches the USAF might pursue to address the chronic problem of pilot manning as a generalizable use case for all services. Specifically, system dynamics modeling was used to answer the research question: *How can the Air Force achieve an end strength of 21,000 pilots by* 2030?

Based on previous research covered in the Literature Review and analysis of the system dynamics modeling, this research resulted in the following recommended actions the Air Force might consider to reach the desired pilot end strength by 2030:

- Increase the number of pilot candidates who annually enter the IFT to 1,750 trainees from 1,300.
- Work to achieve parity between manned and unmanned platforms in the next 10 to 15 years.
- Identify and implement more flexible personnel actions for service length requirements, assignment selections, and incentive pays.
- Increase pilot-related education programs and educational opportunities for all service members.

The military use case of human capital management is only one part of a much larger system, requiring continued examination of military force structures and the population that supports them. Manning shortfalls create undue stress on personnel within the system and drive incentive pays and term commitments higher and longer. As a practical use case, the modeling served to understand better the behavior of the Air Force

pilot manning system over a prescribed period. Future research in this area should include examining the policy recommendations listed in this conclusion and their applicability to human capital management in other services based on the dynamics and demands of the current and foreseeable strategic environment.

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