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Artificial Intelligence:

Winning the Talent Management Race

by Yvette Kushmerick

Tech advances like AI are changing the face and the pace of warfare. AI and related technologies will give us both an information and an operational edge... and that means a strategic advantage.

– Secretary of Defense Lloyd J. Austin III, Remarks at the Global Emerging Technology Summit of The National Security Commission on AI.

AI competition will not be won by the side with the best technology; it will be won by the side with the best, most diverse, and tech-savvy talent.

– National Security Commission on Artificial Intelligence. Final Report: National Security Commission on AI. March 19, 2021.

Artificial Intelligence (AI), defined by the Department of Defense as the ability of machines to perform tasks that normally require human intelligence, has the potential to fundamentally "change the nature of war," realizing the next military revolution in the twenty-first century.[1] Recognizing the profound impact AI has as a military application has led to a technological race between the United States and the People's Republic of China.[2] While AI debuted on center stage in 1997 when IBM's system, Big Blue, defeated the world chess champion, Gary Kasparov, in a six-game match, AI did not get a standing ovation until Google DeepMind's AlphaGo system defeated the internationally top-ranked Go player, Lee Sedol, in 2016.[3] There are 361 possible first moves per side in Go and 10^{170} total possible board configurations, making it a googol (1 followed by a hundred zeros) times more complicated than Chess. When compared to the total number of atoms in the observable universe, between 10^{78} to 10^{82} atoms, the gravity of AI's power becomes evident. Many argue this watershed moment marks the commencement of the AI race.[4]

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The competition for AI leadership and its outcome will have significant consequences on international politics.[5] Chuck Hagel, former Secretary of Defense, and Christian Brose, previous staff director of the Senate Armed Services Committee under Chairman John McCain, advocate for the U.S. to develop military applications of AI to regain a qualitative advantage over strategic competitors.[6] The U.S. military does not have a monopoly on AI-enabled big data analytics in the same way it did for precision-guided munitions, stealth technology, and Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) in the 1980s.[7]

The race to harness AI for economic, industrial, social, and, most importantly, military use, has the potential to shift the balance of power between the U.S. and China, and fundamentally change the post-World War II international order.[8] The National Defense Authorization Act for Fiscal Year 2019 formed and instructed the National Security Commission on AI ("the Commission") to examine the current AI operational environment and offer recommendations on how the U.S. can create a competitive advantage. According to the Commission, the U.S. has not grasped the profound influence AI will have on national security, nor is the U.S. prepared to compete in the AI era.[9]

The Commission's Final Report, *The Department of Defense AI Strategy*, and China's New Generation AI Development Plan all indicate the crux of both the U.S. and China's national AI capability as being the cultivation of talent pools in the fields of Science, Technology, Engineering, and Mathematics (STEM).[10] The technological race between the United States and China for AI leadership will largely manifest itself in the competition for talents, because the holy grail of technological breakthroughs is rare talent.[11] The Commission regards talent as the most essential requirement for succeeding in the AI race with China because "it drives the creation and management of all other elements."[12] AI competition will not be won by the side with the best technology; it will be won by the side with the best, most diverse, and tech-savvy talent.[13]

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The Race for STEM Talent

Since Chinese President Xi Jinping's address to the 19th National Congress of the Chinese Communist Party in October 2017, during which he rallied integration of the Internet of Things, big data, and AI initiatives to achieve great power status, the quantity of publications, patents, and personnel in AI-related fields increased steeply.[14] President Xi aims to advance China's leadership in space technology, robotics, nanotechnology, molecular genetics, solar, quantum information sciences, autonomous systems, and advanced material manufacturing.[15] China's advantage in AI stems from three critical assets: the quantity of computer science and engineering talent, vast structured data sets, and the national strategy of military-civil fusion.[16]

Under China's 2017 AI Education Strategies, not only is AI education mandated in China's primary school system but to achieve this goal, technology companies are required to partner with schools and universities to train students.[17] The curriculum encompasses python programming, AI, the Internet of Things, and big data processing.[18] The centralized control nature of AI development under the People's Republic of China's Next Generation AI Plan is in stark contrast to the United States' approach to the AI race.[19] "Only 47 percent of United States public high schools teach computer science in 2020, which is an increase from 35 percent in 2018."[20] At the undergraduate level, China implemented two primary mechanisms for AI training: AI institutes and standardized AI majors in 345 Chinese universities as of 2021.[21] In addition to the internal cultivation of STEM talent pools, China issued policies to attract international AI talents from universities and research institutions in developed countries.[22]

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With a numerical advantage in STEM graduate degrees, China is well-equipped to develop a robust, medium-term AI talent pool.[23] The Commission highlighted that in the fourteen years between 2000 and 2014, China increased its STEM graduate output by 360 percent, while the United States only increased output by 54% during the same period.[24] In 2020, there were over 430,000 computer science positions in the United States but only 71,000 new computer science graduates from United States universities.[25]

Challenges to recruiting and retaining AI-related talent in the United States Government are due to the inability of the government to compete with private-sector salaries, the cumbersome hiring process, the slow security clearance process, and what many STEM degree graduates perceive as not meaningful work.[26]

The formidable task of gaining and maintaining a technological advantage in the AI race is not unique from a historical perspective. There are three notable instances in which the United States entered a technological race from a position of disadvantage, the personnel in the technological race required high competence in STEM fields, and the United States ultimately succeeded over an adversary in the race. The race to break adversary cryptographic systems, and the race for the atomic bomb during WWII, and the space race of the 1950s and 1960s offer lessons to shape the national AI initiative of building an AI-ready workforce.

At the start of WWII, the United States fell behind competitors in cryptanalytics. However, the United States prevailed over the Axis Powers by identifying the gap, discovering, and developing the right talent, and creating the technology to support the talent, which ultimately led to deciphering German and Japanese codes.[27] Perhaps the most consequential of the examples was the race for the atomic bomb, renowned as the Manhattan Project. The success of the Manhattan Project had immediate and strategic implications. The Space Race with the Soviet Union in the 1950s and 1960s in which both sides sought to achieve superior spaceflight capabilities called for a national reckoning for gifted and talented mathematics and science students. Common talent management themes from three historical technological races are:

1. The creation of an organization with clearly definable goals under centralized leadership,
2. An environment with a sense of urgency,
3. A diverse team of people representing more than one national origin, color, religion, socioeconomic stratum, and sexual orientation,[28]
4. A team with a shared sense of value in the work,
5. Recruitment direct from universities by renowned members in the scientific field to which members were being recruited, and
6. An environment where the decision-makers value members for expertise.

Cryptanalysis during WWII

During WWII, the United States systematically recruited tens of thousands of women to conduct the tedious and mentally daunting top-secret process of intercepting and deciphering German and Japanese cryptographic codes to discover the enemy's order of battle, locations, disposition, and strategic direction.[29] Women, identified for prowess in mathematics, science, and foreign languages, and possessing "character, loyalty, and grit," received a letter from the United States Government asking two questions: do you like crossword puzzles, and are you engaged to be married?[30]

In September 1941, Rear Admiral Leigh Noyes wrote a letter to Ada Comstock, the president of Radcliffe College, the women's counterpart to Harvard. This initial connection between Rear Admiral Noyes and Ada Comstock ignited the women cryptanalyst recruiting program. Ada Comstock, at the request of the Navy, connected with Deans and Presidents at the Seven Sisters Ivy League schools: Bryn Mawr, Mount Holyoke, Barnard, Vassar, Smith, and Wellesley, to identify women based on their educational competence, ability to keep a secret, United States citizenship, and lack of close ties with other nations.[31] Selected women attended weekly training courses in cryptographic security, basic and advanced cryptography, International Business Machines theory, code compilation, cryptanalytic worksheets preparation, and foreign languages: Japanese, German, Italian, French, Spanish, and Portuguese, frequently with Pulitzer Prize-winning professors.[32]

After the attack on Pearl Harbor in December 1941, the Secretary of War, Henry Stimson, requested a list of the best seniors in the field of sciences from his cousin who happened to be the Dean at Goucher College, a four-year women's college known for its science departments.[33] "As war engulfed the nation, the secret recruiting summonses continued to go out in 1942, 1943, and 1944 as cryptanalysis proved crucial to disrupting enemy operations and saving Allied lives."[34] While the Navy focused on college recruitment, the Army targeted women in career fields available to women with quality education, school teachers.[35] The Army campaigned to recruit women at teaching colleges as well as school teachers in the field who were interested in a career change in remote cities and rural communities.

Recruiting cryptanalysts to decipher German and Japanese encrypted war codes was of the highest priority for the United States War Department. The massive emphasis on cryptanalysis led to a "harrowing" sense of urgency that may only be present in the event of total war.[36] "In July 1943, there were 269 male officers, 641 enlisted men, 96 female officers, and 1,534 enlisted women cryptanalysts."[37] They represented a cross-section of United States women "from different economic and social classes, from all parts of the country, and from a multitude of racial origins and religions."[38] At their peak, women comprised eighty percent of the total cryptanalyst force. Additionally, due to Eleanor Roosevelt's advocacy, twelve

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to fifteen percent of the cryptanalysts were to be black.[39] Not only were cryptanalysts during WWII a diverse group, but the manner in which the cryptanalysts operated was particularly inclusive in its approach to novel ideas. "To a striking degree, the organizational structure for cryptanalysts was a 'flat' organization, an egalitarian work culture in which good ideas could emerge from any quarter and be taken seriously."[40] By their own testimony, the cryptanalysts stated that the work environment was daunting, tedious, frustrating, and inculcated sadness but the importance of the national security mission kept them eager on the task.[41]

The contributions of the cryptanalysts to the Allied victory cannot be directly measured but their impacts are clear.[42] President Eisenhower credited the women cryptanalysts with shortening the war by two years due to their ability to intercept, decipher, understand, and convey the enemy's campaign, disposition of U-boats, Panzer divisions, Luftwaffe targets, and the High Command itself.[43] In the Pacific theater, the cryptanalysts, after discovering patterns in Japanese message traffic, built a "Purple" analog machine to decode Japanese diplomatic messages, which ultimately led to discovering a travel itinerary for Admiral Yamamoto, the Japanese commander who orchestrated the attack on Pearl Harbor.[44] Using the deciphered itinerary, Naval Admiral Nimitz devised a plan to target the Japanese Admiral, called Operation Vengeance.[45] On April 18, sixteen Army P-38s took off from Guadalcanal airfield for Bougainville where the fighters came into contact with Japanese fighters and two bombers. After United States forces shot down the Japanese bombers, "Yamamoto's body was found in the Bougainville jungle, his white-gloved hand clutching his sword."[46] The orchestrator of the 'Day of Infamy' was dead.[47]

By the time the United States entered WWII, it had domestic pools of talent from which to enlist for a special national security project.

The Race for the Atomic Bomb

The race for the atomic bomb is an exemplary example of the six talent management themes: centralized leadership, sense of urgency, diverse teams, shared sense of value in national security work, tailored university recruitment, and a working environment where the decision-makers value members for expertise. In the 1930s, as fascism crept over the European continent, brilliant scientists, engineers, mathematicians, and technologists fled to the United States. They fled Nazi or Mussolini regimes, delivering a powerful combination of talented and politically motivated émigrés.[48] This influx led to the United States' cultivation of a world-class capacity in science and technology.[49] By the time the United States entered WWII, it had domestic pools of talent from which to enlist for a special national security project.

In 1942, President Roosevelt authorized a single project to combine various plutonium and uranium research efforts with the goal of weaponizing nuclear energy, the Manhattan Project, led by the head of the Army Corps of Engineers, Brigadier General Leslie Groves.[50] The United States set up the Military Policy Committee which included one representative each from the Army, the Navy, and the Office of Scientific Research and Development so that scientists would have better access to decision-makers.[51] The organizational structure under a centralized leader, which eliminated previous parallel but separate structures, helped remedy early deficiencies that slowed the decision-making process.[52] A decisive and demanding leader, General Groves selected three primary sites to manufacture the atomic bomb: Oak Ridge, Tennessee for uranium enrichment, Los Alamos, New Mexico for weapons research, and Hanford, Washington to produce plutonium from the uranium isotope U-238.[53] The reorganization of the atomic project under the Department of the Army with an Army general at the helm "renewed the project's sense of urgency."[54]

General Groves identified theoretical physicist, J. Robert Oppenheimer, to lead the creation, test, and evaluation of atomic bombs at the Los Alamos Laboratory in northern New Mexico beginning in 1943.[55] J. Robert Oppenheimer spent the first three months of 1943 crisscrossing the country traveling to theoretical physics and radiation laboratories at Stanford University, University of Minnesota, Princeton University, Cornell University, and Massachusetts Institute of Technology to personally recruit scientists to work at Los Alamos.[56] Oppenheimer, who was opposed to serving in uniform, advocated keeping Los

Alamos National Laboratory an academic community, mostly because many of the scientists objected to working as commissioned officers and feared that the military chain of command was ill-suited to scientific decision-making."[57] In particular, Robert F. Bacher and Isidor I. Rabi from the Massachusetts Institute of Technology's Radiation Laboratory thought a military environment was not conducive to scientific research, to which Oppenheimer promised that the laboratory would remain civilian through 1943.[58] Every scientist "had the impression that Oppenheimer cared what each particular person was doing."[59] "In talking to someone he made it clear that that person's work was important for the success of the whole project."[60] This effort proved to be successful and led to a population growth that doubled every four months.[61]

Oppenheimer created an environment where creative scientific ideas could flourish by orchestrating a forum, or colloquium, to foster open-ended brainstorming sessions with colleagues, students, and newcomers.[62] Furthermore, the Los Alamos laboratory organizational chart was a circle.[63] The flat organizational structure was meant to connect every possible group to every other group. Oppenheimer argued that members of each group needed to be in a room together on a regular basis to sort through difficult areas of research or experimentation.[64]

After delivering a proof of concept, the project expanded to its height of approximately 130,000 people working at thirty-seven facilities across the United States. The total cost of the Manhattan Project was almost $2 billion dollars and took two and a half years to complete. On August 6, 1945, the United States dropped Little Boy in the city center of Hiroshima, Japan, followed by Fat Man on August 9, 1945, in Nagasaki. Japanese Emperor Hirohito surrendered via radio broadcast on August 15, 1945, bringing an end to WWII.[65] The diverse set of talent not only brought WWII to an end but the United States scientists contributing to the war effort pulled the center of gravity for science and technology from Europe, leading to the United States becoming the scientific center of the world.[66]

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The Space Race

The Cold War space competition between the United States and the Union of Soviet Socialist Republics (USSR), which centered on the race to the moon, offers both an exceptionally revealing historical case and larger implications for space and technology development."[67] The USSR launched Sputnik 1 into space on October 4, 1957, catapulting the world into the Space Age, and with it the space race between the United States and the USSR.[68] With a 500% increase in budget, the newly minted National Aeronautics and Space Administration (NASA) employed 34,000 direct employees and 375,000 industrial and university contractors to propel its lunar landing program.

The United States solicited German-American engineer Dr. Werhner von Braun, former chief engineer of the Nazi V-2 program, to direct NASA's Marshall Space Flight Center where he and his team began the development of the Saturn V super-heavy lift launch vehicle.[69] Hundreds of skilled engineers, machinists, and fabricators from across the country spent thousands of hours developing each component of the Saturn V before the components were assembled at the Kennedy Space Center in Florida.[70] In July 1959, NASA launched Apollo 11, and astronauts Neil Armstrong, Edwin "Buzz" Aldrin, and Michael Collins landed on the moon. Upon Armstrong's famous words, "one small step for man, one giant leap for mankind" from the surface of the moon, the space race was effectively over.[71]

The [National Defense Education Act] helped the United States gain an advantage over the USSR during the space race...

In 1958, the United States, realizing the deficit in talented STEM students to keep pace with the country's strategic vision, passed the National Defense Education Act (NDEA), which stimulated the advancement of education in STEM and foreign languages.[72] "The law provided federal funding to 'insure trained manpower of sufficient quality and quantity to meet the national defense needs of the United States'"[73] According to James Brahm's "STEM Education Should be a National Security Priority" in the *Space Force Journal*, due to Spacepower being an inherently technological instrument of politics and the fact that a state's ability to exert influence in the space domain is linked to its technical-informational base, scientific and technological education fortifies national defense requirements.[74] Technological education increases the capacity of the scientific base, develops the technical understanding of non-technologists, improves resilience to disinformation, and inspires interest in space.[75]

The NDEA was designed to "promote the importance of science, mathematics, and foreign languages for students, authorize more than $1 billion toward decreasing student loans, funding for education at all levels, and funding for graduate fellowships."[76] According to the United States Senate, the NDEA was one of the most successful initiatives to bolster higher education and is directly attributed to increasing university enrollments from 3.6 million in 1960 to 7.5 million in 1970.[77] The NDEA helped the United States gain an advantage over the USSR during the space race and "ultimately played an important role in the United States' victory in the Cold War."[78]

Harkening back to the fear that the United States lost the strategic edge over the Soviets in 1957, the Commission recommends that the United States pass an NDEA II. Specifically, the Commission recommends a second NDEA that focuses on developing digital talents, such as data science, computer science, mathematics, statistics, and information science, at the kindergarten through twelfth-grade levels and offering scholarships at the undergraduate, graduate, and doctorate levels. "Ultimately, the goal of NDEA II is to widen the digital talent pool by incentivizing programs for underrepresented Americans."[79]

Recommendations

The three historical examples offer lessons learned on how the United States can cultivate talent pools to meet national security initiatives. Identified inferences of talent management principles from cryptanalysis during WWII, the race for the atomic bomb, and the Space Race are clearly definable goals under centralized leadership, a sense of urgency, a team of diverse members, a sense of collective value, tailored university recruitment, and an environment where the decision-makers value members for their technical expertise. The principles may be applied at both the Department of Defense and national levels. Departments of Defense: Navy, Army, and Air Force are desperately attempting to adopt AI solutions but lack a sense of urgency to realize AI capabilities.[80] "A lack of national urgency is dangerous at a time when underlying weaknesses have emerged in our AI ecosystem that impair innovation, and when viewed against the backdrop of China's state-directed AI progress."[81]

The Department's Chief Digital and Artificial Intelligence Officer (CDAO), appointed in February 2022, should oversee the Service's AI initiatives, and offer a standardized solution for structured data sets, while concurrently creating an organizational structure with each Service and Combatant Command's CDAO to spur creative ideas for data storage and labeling, algorithm optimization, and AI use-cases.

Mimicking successes during WWII, the Department of Defense should create a centralized organizational structure with access to decision-makers across the military services while simultaneously fostering a flat organization for researchers, coders, and engineers. By eliminating cumbersome bureaucratic stovepipes, the CDAO has an opportunity to provide strategic direction and evoke a sense of urgency required to compete in the AI race with China.

In every historical example, the teams represented sets of diverse individuals. Approximately eighty percent of cryptanalysts during WWII were women. Likewise, many of the initiators behind the atomic bomb and the race to the moon came from repressed countries during WWII. The Department of Defense should relook at how it recruits diverse minds, diverse leaders, and diverse talent. In addition to recruiting university seniors by leveraging experts in STEM fields, the Department should consult specifically with those STEM experts with diverse backgrounds. Recruiting campaigns should focus on universities known for diverse students (e.g. Historically Black Colleges and Universities or universities with a large immigration population). At the federal level, federal agencies should consider retaining elite foreign students upon post-baccalaureate graduation or after post-doctoral fellowships.

Furthermore, the Department of Defense should cultivate respect for and promotion of technical competence. Specifically, the Services should track talent related to information warfare: computer language coding, data scientists, engineers, scientists, and AI-related skill sets even if that member is not slated to a position in which those skills are required. Only by tracking those skill sets can leaders offer employment flexibility and remain tied to specific capabilities throughout their service. Members hired for special duty assignments often display personal interest and initiative in the field for which they are hired. Fostering the honing of technical acumen for software developers, engineers, cyber operators, highly technical exploitation analysts, data scientists, and statisticians is in the best interest of the member and the U.S. military. Funding from a second NDEA should extend to job-enhancing training courses and certifications: information technology, software and hardware development, and AI. Finally, the NDEA II should provide funds for collaboration events during which government, industry, academia, and research laboratories may conduct technical demonstrations and compete in prize challenges. A recent example is the 2020 President's Capture the Flag event. Teams of experts in AI and related fields would have the opportunity to collaborate to solve tough technology challenges.

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Thus far the recommendations have been tailored to the U.S. Department of Defense. Cultivating pools of talented STEM members for military and federal service starts at the strategic level. During the Space Race, the United States passed legislation to build pools of people to cultivate the future national security workforce. The NDEA provided funds at the university level but failed to realize the potential of providing funds for initiatives at the primary and secondary education levels: elementary, middle, and high school. According to the 2018 National Science and Technology Committee on STEM

(CoSTEM) 5-Year STEM Education Strategic Plan, "basic STEM concepts are best learned at an early age—in elementary and secondary school—because they are the essential prerequisites for a lifetime in the workplace."[82] The CoSTEM further asserted that a basic understanding and comfort with STEM and STEM-enabled technology have become a prerequisite for full participation in modern society. The 2018 CoSTEM strategic plan coincides with the recommendations from the Commission to build a future AI-enabled workforce. The Commission, recognizing the future implications of the lack of technical training for American children, calls for the NDEA II to fund:

- STEM and AI-focused school and after-school programs,
- STEM and AI-focused summer learning programs,
- K-12 STEM teacher recruitment, training, and retention, and
- STEM scholarships, grants, and fellowships.[83]

The Commission also recommends that state legislatures consider making statistics in middle school and computer science principles in high school a requirement.

To achieve superiority in the AI race against China, the United States needs both a strategic initiative to build the next generation of AI-savvy Americans and a Department of Defense-level initiative to organize a construct to drive the AI initiative with a sense of urgency. The United States should not wait until competition turns into conflict to realize it should have invested more heavily in AI capabilities. A synergistic, whole-of-government approach is required for the United States to maintain a competitive advantage over China in the AI race. ***IAJ***

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