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Prometheus Unbound

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Prometheus Unbound

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Abstract

The United States Navy was founded in 1775, just as the First Industrial Revolution started. Consequently, the U.S. Navy has matured in a vibrant, innovative technology environment throughout this and the three subsequent industrial revolutions. The U.S. Navy has consistently maintained an innovative, forward-leaning posture, repeatedly and progressively adopting innovative technologies into operational service. Ironclads, dreadnoughts, naval aviation, nuclear power, submarine-launched ballistic missiles, guided missiles, jet airplanes, and phased array and digital radars are the highlights of the U.S. Navy's skill at technology adoption.

While typically innovative and progressive, the U.S. Navy has entered a new, regressive phase, trailing its strategic maritime competitors in adopting technology innovations, like autonomous vehicles, quantum computing, hypersonics, and other groundbreaking maritime innovations.

This project assessed two centuries and three industrial revolutions of the U.S. Navy's innovative technology adoption practices. It merges those organizational learning and innovation adoption principles with leading modern organizational theorists and practical innovators into a single conceptual framework that uniquely applies to the United States Navy.

This novel conceptual framework merges current organizational learning frameworks and behavioral models with time-proven and successful U.S. Naval empirical practices. They explicitly define principal U.S. Navy organizational practices that are internally culturally acceptable, performance-proven, and not overly complex, creating, in effect, a road map, a leaders' guide, for future U.S. Navy technology adoption techniques and organizations for the 21st century.

Introduction

In the last 25 years the U.S. Navy has fielded exactly two classes of surface warships (LCS 1 & 2 class), one new combat aircraft (F-35), no new classes of submarine, and no new uncrewed air, surface, or undersea vehicles or ships. This lackadaisical pace has not been seen since the 25-year gap between the first American steamship sailed (Fulton) in 1814 and the Commissioning of the USS Mississippi, soon to be one of Commodore Perry's ships that opened Japan to trade, in 1839 (Bennett,1896).

Since 1839, the United States Navy has invented "Silicon Valley" rapid technology adoption practices an entire century and a half before there was a Silicon Valley. The U.S. Navy built 50 steamships before the American Civil War (Bennett, 1896). In 1861, the USS Monitor went from a paper model to a combat victory in six months. In 1881, the New Steel Navy fielded four revolutionary steel warships in less than a decade, followed by the U.S. Navy's first battleship in 1890 and simultaneous combat victories in the Atlantic and the Pacific oceans in 1898. Submarines entered American naval service in 1900. America's first dreadnought-style battleship, USS South Carolina, followed just 12 years later, in 1910. Naval aircraft were flying operational missions by 1914. By 1916, the U.S. Navy's Fleet was "Second to One," and then quickly became "Second to None" by 1934. The Monitor's ironclad Sailors of 1862 would not have recognized the American ships, submarines, and aircraft that fought in World War I, just 56 years later. Even after all that, the U.S. Navy fielded a blizzard of innovative ships, aircraft, and submarines until 2000. A turn-of-the-century sailor from 1900 would not recognize the U.S. Navy's turn-of-the-century Fleet in 2000, just as Bill Hewlitt and David Packard would not recognize the industry they created, Silicon Valley, just 53 years after it was first popularized in 1971. But a sailor from 1965, 60 years ago, would be perfectly comfortable in today's Fleet. Jet airplanes, nuclear submarines, air defense cruisers and destroyers, and nuclear-powered aircraft carriers remain in service today, many the same, if not similar, to those of the Vietnam War era.

What happened?

"*Prometheus is best known for defying the Olympian gods by taking fire from them and giving it to humanity in the form of technology, knowledge, and, more generally, civilization*" (Wikipedia, 2025). The U.S. Navy's leaders from 1836 through to 2000 were modern Prometheuses, creating organizations and processes that gifted the Navy knowledge and skills, thus creating abilities that revolutionized naval technology invention and fleet adoption practices. That began the golden age of American naval innovation.

What did those early leaders do to release Prometheus to the custody of the U.S. Navy?

Writing on military innovation today often conflates three related topics: *invention*, *adoption*, and *adaptation*. Closely affiliated with these is the complex term "*a Revolution in Military Affairs*," or RMA. *Invention* is precisely what it sounds like: inventing a new machine, process, or technology(O'Sullivan & Dooley, 2008). This paper focuses on *adoption,* the process of incorporating an invention into the established force structure of military service (Denning & Dunham, 2010). *Adaptation* is using existing, adopted technology in a new or unique way other than as envisaged initially (Lacey & Woods, 2007). *A Revolution in Military Affairs* is the term used to describe what happens when a suite of modern technologies, once invented, adopted, and adapted, fundamentally changes the nature of combat operations (Rogers, 1995). Maritime warfare is amid an RMA today due to the cumulative effect of new 21st-century technologies and the suite of maturing technologies from the late 20th century.

Peter Rosen's *Winning the Next War* profiles two core methods for introducing military innovation: during peacetime through personnel assignments and organizational changes and wartime innovations implemented through adaptation, operational, and doctrinal changes. He provides case studies supporting his thesis. The most significant changes address organizational and leadership issues, not technological factors (Rosen, 1991).

Adoption of an invention is not a speedy process. Studies have shown that commercial progression from invention to adoption can take between 30 and 40 years (Doraszelski, 2004). and such a scale is seen in the military and naval spheres. The first U.S. Navy–funded steam-powered ship sailed in 1807, but the first U.S. Navy steamship was not commissioned for another 29 years. The first self-propelled anti-ship torpedoes were invented in 1866, but their first tentative use in combat was not until 1894–1904, and their first effective combat use wasn't until World War I, 48 years later (O'Hara & Heinze, 2022). A range of factors in the invention/adoption process can accelerate or retard technology adoption in the naval sphere, and those will be enumerated later in this paper. During the fielding process, the conflating factors of invention, adoption, adaption, and RMA come into play.

In one of my prior contributions to the field, I cite the utility of engineering operational flexibility in the designs of warships and weapons systems, especially in the modern era, to hasten the adoption of emerging technologies and wartime tactical adaptations. My conclusions are based on historical examples of such utility from the Spanish Armada of 1588 to 2021. In every case, the principal challenge is organizational versus technical, and the principal obstacle is leadership (or lack of) to meet operational performance objectives, not the lack of engineering tools and rigor to articulate a better outcome (Lewis, 2022). Larrie Ferreiro, in *Bridging the Seas: The Rise of Naval Architecture in the Industrial Age, 1800–2000,* calls this necessary engineering rigor “the ghost in the machine,” the underlying technical discipline and accompanying good engineering practices associated with adopting an innovative technology into the Fleet. The flash of brilliance of an invention (or determined act of invention, as you wish) must be followed by the complex, often tedious work of design, engineering, functionality, usability, sustainability, and all other factors that matter to both Sailors and naval leaders if they are to use a new technology to wage war at sea (Ferreiro, 2020).

Beyond the Navy, society, in general, has been changing rapidly, creating dominant technological effects that coincidentally started with the birth of the United States and the U.S. Navy and continue through today: the four industrial revolutions. These are defined as the first industrial revolution (1IR), the second industrial revolution (2IR; Lanteri, 2019), the third industrial revolution (3IR; Evron et al., 2023), and the current fourth industrial revolution (4IR; Lanteri, 2019). The 1IR includes the invention and adoption of steam and steam propulsion. The 2IR encompasses the invention and adoption of electricity, machinery, radio, internal combustion engines, and manufacturing systems. The 3IR started with the birth of computers, computer programming, networks, satellites, and the internet. Our current 4IR includes cloud computing, quantum computing, artificial intelligence, machine learning, and data analytics (Lanteri, 2019).

Denning and Dunham’s revolutionary 2020 innovation taxonomy, *The Innovator’s Way*, provides a robust methodology and a practical conceptual framework that provides a definitive, systematic approach to defining, organizing, and implementing the adoption process. Denning and Dunham define a prime innovation pattern (PIP) that, when executed, produces eight innovation practices divided into three phases (Denning & Dunham, 2010).

Phase I: The Main Work of Invention

1. Sensing
2. Envisioning

Phase II: The Main Work of Adoption

3. Offering
4. Adopting
5. Sustaining

Phase III: The Environment for the Other Processes

6 Executing
7. Leading
8. Embodying

Each of these attributes encompasses an operational definition. They can be indexed and assessed when comparing adoption cases from history by these attributes, then compared using the PIP rubric. This provides a common lexicon and measurement template for all U.S. Navy technology adoption events across all four industrial revolutions. All adoption activities, successful or not, can be parsed into one of these eight independent variables (Lewis, 2024).

The 2010 Denning and Dunham PIP tracks closely to other, later innovation adoption rubrics (Taylor & Hall, 2013), and implementation research methods (Peters et al., 2014) that stress sense-making, user communication, and user-provider interactions as necessary precursors to adopting innovative ideas and processes into an established community of practice.

Of applicability to this paper, Phase III "The Environment for the Other Processes" PIP attributes are (Denning & Dunham, 2010):

1. **Executing.** Requires domain-specific and conversational skills. Effectiveness depends on completing actions within a domain as promised in conversations.
2. **Leading.** "The point of innovation leadership is adoption and integration of new practices in a community, not sustaining the power of a leader." These include focus on followers, focus on outcomes, and observability of the outcomes produced.
3. **Embodying.** "The innovator's challenge is to get the members of a community to embody a new practice."

Part I: Leadership—Founding an Audacious New Navy

The United States Navy was disbanded after the Revolutionary War, and its management and functions were incorporated into the Department of War. This Cabinet post also administered the United States Army. For two decades, this arrangement worked well for the Navy's few warships and the tiny American Army. Piracy had always been a problem in the world's ungoverned seas. Still, a new, organized group of pirate leaders based on the North African coast, the Barbary Pirates, began to practice a highly organized form of piracy, more like a protection racket than simply randomly attacking passing merchant ships at sea. Ransoms were demanded to return ships and Sailors, and protection money was demanded to avoid future attacks—failure to pay generated targeted attacks and outrageous demands. By the early 1790s, unescorted and unprotected American cargo ships were being targeted. Congress authorized the building of warships to protect America's commercial Fleet (Smelser, 1959). With the nation's first warships came the first Naval Constructors. Naval Constructors were established to supervise the construction of the Navy's first six Frigates, authorized by Congress in 1794.

As the government's on-site technical authority, Naval Constructors were the first demonstrated PIP Phase III *executing* attribute, placed there by Secretary of the Navy Benjamin Stoddert, representing the *leadership* attribute through their eventual acceptance by the shipbuilding industry and the active-duty Navy, demonstrating *embodiment (Leiner, 2000).* This represents the first stage of Prometheus's gift: organizational learning through individual learning (Argote, 2021).

Neither American shipyards nor the Naval Constructors had ever built a warship, so they learned together. Of note, the ships were extraordinarily innovative in their design, as was to become evident to the world during the War of 1812. Joshua Humphries, the Chief Constructor, designed powerful preindustrial, technically innovative ships that were designed well beyond the minimal requirements of their stated counter-piracy missions (Toll, 2008) and, in so doing, set an innovative tone for thousands of future U.S. Navy ship designs. Prometheus became unbound.

In a pattern that was to repeat many times over the next two centuries, an ad hoc advisory process was created during the existential naval crisis of the War of 1812, which led Secretary of the Navy William Jones to establish a permanent Board of Naval Commissioners (the "Navy Board") in 1815 to advise the Secretary on complex Naval Matters (Albion, 1980). This represented a second preindustrial step in organizational learning, implementing both *active* and *latent* context that "forms the backdrop of organizational learning," where *active context* defines the members and tools that interact with the organization, and the *latent context* establishes design and duties (Argote, 2021). The Navy Board remained in existence until 1842, when it was overwhelmed by steam and new ordnance technology and was replaced by the Naval Bureau system.

Creating knowledgeable people is the first step in creating a learning organization. Those knowledgeable people can then create tools (Ferreiro's "Ghost in the Machine") to perform tasks to achieve the organization's mission. Once people are knowledgeable, moving them and their tools between organizations allows their knowledge to diffuse throughout the larger organizational entity. It is precisely the organizational learning cycle necessary to impart specialized knowledge across a growing organization.

This is how the U.S. Navy dealt with the rise of 1IR technologies. First, the Navy recognized its knowledge deficit. Then, it sought out people and organizations who had the knowledge and experience the Navy desired (i.e., industry). Finally, it created learning centers in the Navy to create knowledgeable Navy people, built tools, tasks, and organizations to support them, and then proliferated those people and their tools throughout the Navy (Lewis, 2024).

Naval Constructors learned to build warships alongside industry. Then, the Navy Board identified knowledge deficiencies, which generated Navy Schools and the Naval Academy, which, as we will see next, led to the creation of the Bureaus and the Naval Engineers.

Two environmental aspects of organizational learning are *exploration* and *exploitation* (see Figure 1). *Exploitation* maximizes the value of known knowledge and improves upon an established base of practice, information, and knowledge. For wooden sailing ships of the 18th and early 19th century, this was a rich and deep well of over four hundred years of experiential learning and operational knowledge (Lewis, 2022). Its complement, *exploration*, is the discovery of new possibilities and knowledge that can be applied to the situation (York, 2020). This was first used in the U.S. Navy by adopting Joshua Humphries' novel hull construction technique, allowing American frigates to carry more guns than any extant foreign frigate. That difference would almost always guarantee victory in single-ship combat (Toll, 2008).

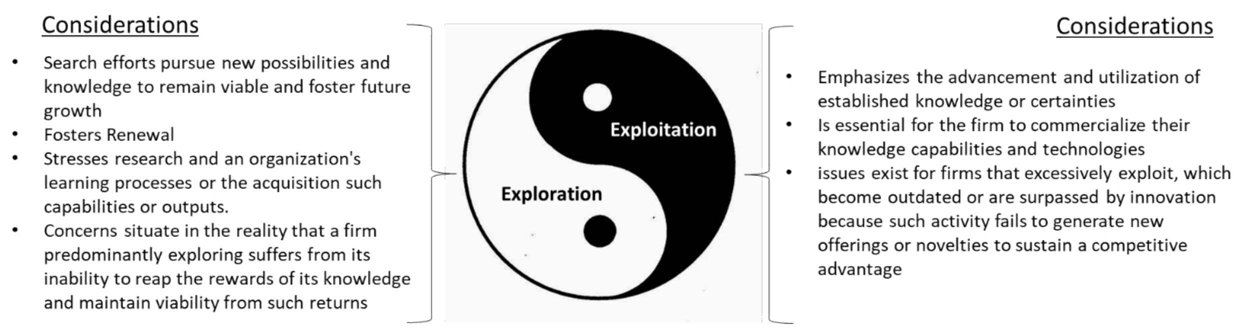

Figure 1: The Yin and Yang of Exploration and Exploitation of Organizational Learning (York, 2020)

As the 1IR suite of emerging innovative maritime technologies expanded, the need for more expertise in the U.S. Navy became an issue. A letter in 1835 from the Naval Commissioners to the Secretary of the Navy, cited in *The Steam Navy of the United States,* says it best:

> from their ignorance upon the subject of steam engines, they are in doubt whether [they have] given the necessary information . . . to make proper offers. They are satisfied that they are incompetent themselves and have no person under their direction who could furnish them with . . . information to form a contract for steam engines . . . the board begs . . . your authority for engaging some person who may be deemed competent. (Bennett, 1896)

In the context of organizational learning, the new *exploring* environment upset the established latent organizational context of the Navy. Hence, the Navy had to discover

new tasks (skills) to be performed, had to find new people (members) to perform them, and had to develop new tools (naval engineering) for them to use during those tasks. All to overcome the changed environment created by the steam propulsion technology.

Freeing Prometheus proved to be more complex than just cutting chains!

The creation of the Bureaus also began a long-standing trend whereby the U.S. Navy preferred empirical design methods over rationalist design practices as defined by the computer scientist Frederick Brooks in *The Design of Design* (Brooks, 2010):

> **The rationalist** believes that man is inherently sound (and reasonable), subject to mistakes, perfectible by education. After the right education, maturing experience, and sufficient careful enough thought, a designer can make a flawless design. The design methodology task, then, is to learn how to reason a design into flawlessness.
>
> **The empiricist** believes that man is inherently flawed and subject repeatedly to temptation and error. Anything he makes will be flawed. The design methodology task, therefore, is to learn how to determine the flaws by experiment, so that one can iterate on the design. (Brooks, 2010, p. 106)

The Bureaus, as *exploring, experiential* learning organizations, assembled teams of highly qualified civilians and military engineers to learn the new technologies of the 1IR, developed new tools and new methods to implement them, and then set about designing and ordering innovative ships and weapons to adopt those new technologies into the Fleet, iterating with each version, model, or class as flaws and defects emerged.

Part II: Leadership—Resurrecting an Audacious Navy

In 1881, the election of President Garfield and the appointment of three extraordinary Secretaries of the Navy revolutionized the U.S. Navy's approach to technology adoption, just as the 2IR was starting. In many respects, the New Steel Navy's birth mirrored the Steam Navy's birth, in that little invention was involved. Apart from armaments, the entire endeavor was based on the diffusion of existing practices from commercial practice and other navies, notably England, for America's New Steel Navy technologies.

Consistent with past best U.S. Navy practice, Secretary of the Navy William Hunt formed an Advisory Board to prepare his modernization report to Congress, which then legislated the creation of a Naval Advisory Board that devised the eventual shipbuilding plan for the new Secretary of the Navy, William Chandler, to propose to Congress for funding. That plan resulted in constructing the foundational "ABCD" ships of the New Steel Navy (Wolthers, 2011). Congress legislated which technologies could be bought from foreign suppliers and which could not, providing a much-needed boost to fledgling 2IR domestic industries. By 1889, modern ship designs, armor, and shafting could be procured domestically, and modern ships could be built in government shipyards and commercial ironworks (Bennett, 1896).

This surge of effective leadership and organizational learning allowed Secretary of the Navy Benjamin Tracy to request funding for the U.S. Navy's first oceanic battleships in 1890, enabling the Navy to finally abandon its century-old mission of single-ship maritime interdiction, trade protection, and distant station operations to be replaced by a bona fide maritime dominance mission—a true American Fleet (Albion, 1980). Eight years later, it was a modern enough Fleet to decisively defeat the second-rate Spanish Navy during the Spanish-American War (Symonds, 2016), announcing America's entry onto the world stage as a significant maritime power.

At the dawn of the 2IR, Secretaries Hunt, Chandler, and Tracy led the transformation of the U.S. Navy from an obsolete, backwater service to a prominent position on the world maritime stage in less than two decades. As the Navy's material condition improved, significant organizational changes were required to continue the momentum they created.

In organization learning theory, this illustrates the ability of the United States to create a competitive advantage through its dynamic capability, which "*a*llows [an organization] to integrate, build, and reconfigure internal and external competencies to engage in a dynamic [operational] environment and provide competitive advantage" (York, 2020). This capability had been demonstrated intermittently during the previous century. However, the creation of the New Steel Navy in 1881 and the American combat victories in 1898 demonstrated a new coherent, sustained maritime dynamic capability. As we will see, the Navy would successfully execute that newly developed dynamic capability for a century until the start of the 4IR.

Close on the heels of the birth of the New Steel Navy in 1881 was Britain's 1905 adoption of the dreadnought-type of "all big gun" battleship as the new premier naval warship, with the first three U.S. Navy ships of that type being commissioned in 1910 (Friedman, 1985), lagging the Royal Navy, then the acknowledged maritime technology leader, by only five years.

Compared to the performance of the dominant Royal Navy, the U.S. Navy's new 1IR and early 2IR organizational learning process had accelerated the American technology adoption rate by a factor of five. Prometheus had been fully released, and the U.S. Navy began to run rampant.[1] This quantum leap in innovative technology adoption practices was the precursor to the U.S. Navy's mid–World War I objective of being "a Navy Second to One." In other words, second only to the Royal Navy (Weigley, 1973).

In just 29 years (1881–1910), the U.S. Navy progressed from being a small, technically backward, third-rate naval power to one aspiring to become the second most powerful Navy in the world (Cable, 1998). This contrasts with the 68 years the Colonial and 1IR Navy took to achieve similar growth in force structure and stature between 1794 and 1865. This second progressive move forward by the U.S. Navy took less than half the time of the first, principally due to improvements in the U.S. Navy's Phase III PIP leadership attributes and effective organizational learning practices. The Navy's profound leadership and organizational changes during that time were the key enablers to its rapid growth in combat power and capability.

After it was founded in 1921, the Bureau of Aeronautics (BuAer) fielded 62 different models of naval aircraft by 1941, including 22 fighter models and 20 seaplane designs. Even though dive bombers were introduced only in the mid-1930s, the U.S. Navy fielded eight unique designs in the six years before the 1941 Japanese attack on Pearl Harbor (Lewis, 2023). Compare that to current U.S. Navy performance: one new aircraft model since 2000. Although the U.S. Navy's naval aviation branch did not exist as an organization until 1921, the naval aviation force that fought and won in the Pacific Theater in 1941–1945, just 20 years later, demonstrated sophisticated aircraft designs and practical combat skills against an equally skilled and capable maritime peer competitor. That level of performance was not gained in one rationally derived, preplanned, orchestrated, and coordinated leap; it was learned through dozens of small, rapid, incremental, empirical improvements executed by a capable learning organization led by empowered leaders and staffed with enlightened and mission-focused members and a growing Argote-based active engineering toolset (Symonds, 2016). Naval aviation matured empirically, not rationally, according to Brooks's definitions.

The organization that the Navy built in the 1IR and early 2IR served them well going into a period of high innovation and technological changes (Kuehn, 2008):

[1] A comparison to today's maritime competitive landscape should give the reader immediate pause.

> The Navy was already organized in a fashion that encouraged operational innovation. They had a relatively flat organizational hierarchy and a tradition of frank communication between its constituent organizations. Managerial control was spread out . . . among several organizations. The sometimes-depressing effect of strong executive leadership on new ideas from the "rank and file" was alleviated to some degree by the healthy collaboration and sometimes competition between the General Board and OpNav . . . to ensure that a powerful CNO did not unduly influence the General Board's advice.

Lastly, the 2IR cemented a viable and vital relationship with industry regarding innovative technologies. As with steam in the 1830s, neither submarines nor aviation had a predecessor technology or product from which to draw Navy expertise. The Navy had to go to industry because industry was the only source of applicable knowledge, skills, and abilities (KSA).

The Navy had not fundamentally changed warship propulsion since the introduction of steam in the 1830s, so the development of nuclear-powered ships in the early 1950s was a change that the U.S. Navy met with a new leader and a new organization. Similarly, the Doolittle Raid on Tokyo in 1942 introduced the Navy to a new long-range maritime strategic strike mission, which it fully adopted after World War II. However, extending that to strategic missiles was utterly new (Reynolds, 1968). Launching maritime strikes from submarines using rockets was an even greater stretch, so, again, a new leader and organization were selected to champion and then adopt these into the Fleet (Sapolsky, 1972).

Lastly, after multiple failed attempts to bring new, computer-controlled radar technology to the Fleet, another new leader was found, and a new organization was created to adopt this innovative technology into the Surface Navy's Fleet of cruisers and destroyers (Wildenberg, 2024). The U.S. Navy discovered what is now known as the Lean Startup Model, first proposed by Steve Blank.

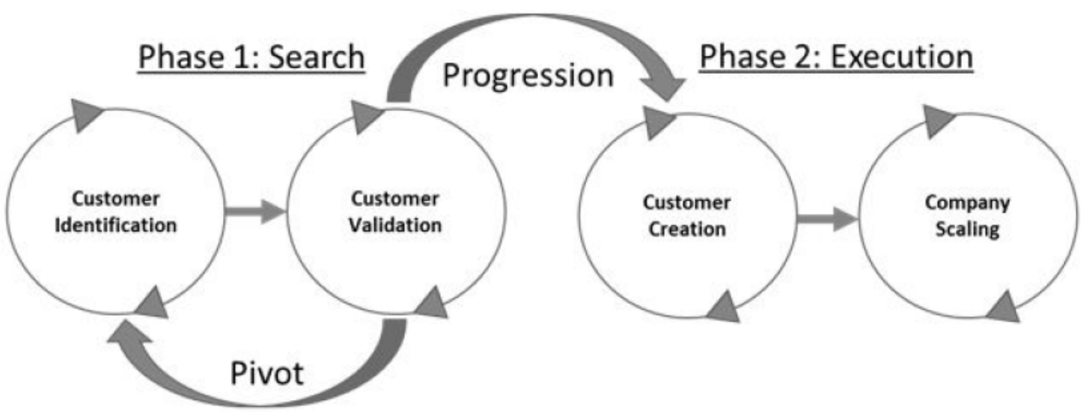

Figure 2: The Customer Development Model
(Blank, 2013)

This is the practice of focusing on the customer before defining the product. It conforms with Brooks's model of empirical design and Denning and Dunham's PIP Phase I and II processes of sensing, envisioning, offering, and adopting.

The vexing technologies of the 3IR required the U.S. Navy to refine their already proven novel approach to organizational learning, one that presaged Blank's model, today's build-measure-learn (BML) lean startup learning model later popularized in the Boyd observe, orient, decide, act (OODA; Woods, 2013) and the Deming plan-do-check-act rubrics (York, 2020). These processes seek to produce a minimum viable product (MVP), which is then iterated through resultant empirical cycles of learning to deliver a series of incrementally improved products in rapid succession (Borotini et al., 2021; Eisenmann et al., 2011; Reis, 2020):

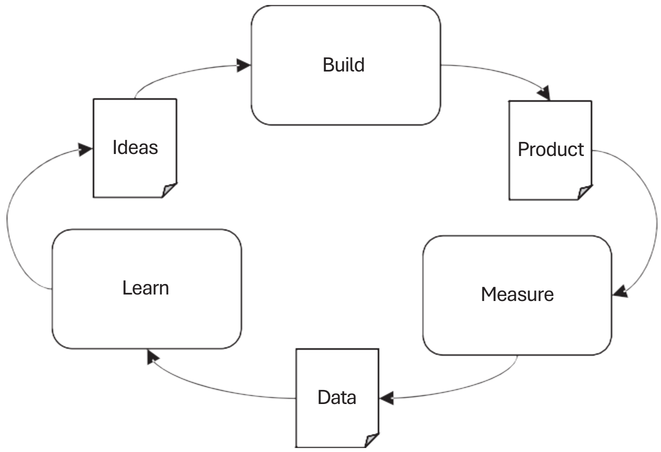

Figure3: Lean Startup's BML Cycle and Learning Actions

In 1955, the USS Nautilus, SSN 571, reported herself "underway on nuclear power." (Rockwell, 2022). Between 1954 and 1961, just seven years, the U.S. Navy commissioned 11 *classes* of nuclear submarines, 22 boats in all, including two classes of an entirely new type of submarine, a ballistic missile submarine. "The Navy explored the entire design space: conventional hulls, albacore hulls, twin screws. Single screws, one reactor, two reactors, water-cooled reactors, and sodium-cooled reactors. Fast and less-fast boats" (Lewis 2022). The Navy also built the first-ever nuclear-powered cruiser and aircraft carrier in the same period.

The USS Nautilus was a true MVP, and the 22 boats that followed were examples of BML practices applied in the very technically challenging, entirely new operational environment of nuclear-powered submarines. Similar operational learning behaviors were demonstrated for the 1956 Polaris program, where the Polaris A1 submarine-launched ballistic missile (SLBM), deployed in USS George Washington, SSBN 598, was an MVP (Sapolsky, 1972), and the 1968 Aegis Program, where USS Ticonderoga, CG 47, the first Aegis cruiser, was also an MVP (Wildenberg, 2024).

Using a specialized portfolio-oriented organizational structure for all three innovative technology adoption projects was critical to their success. This precisely evoked prior U.S. Navy empirical practices for the first six Frigates in 1794, the Ironclad Board that delivered three different ironclad ships in 100 days, the Naval Advisory Board that produced the four different "ABCD" ships in a decade, and the creation of the Bureau of Aeronautics in 1921 that delivered 62 different models of aircraft in 20 years. The Navy Nuclear Power Program (NNP), The Strategic Systems Program (SSP), and the Aegis Program (PMS 400) continued that unique and prescient U.S. Navy organizational rubric into the 3IR. All three implemented Argote's innovative, fact-based learning organizational culture and structure.

Part III: Prometheus Chained

In 1947, at the end of the 2IR, the United States decided to unify the armed forces into a single Department of Defense. The new structure codified the informal, ad hoc leadership and advisory groups formed before and during World War II (Albion, 1980).

This dramatically changed the U.S. Navy's Phase III PIP role in technology adoption by introducing an intermediate, higher-level decision-maker between the Secretary of the Navy and the President and Congress. Another leadership and decision-making layer, and a new, inexperienced one at that, was inserted into an existing, successful maritime technology adoption process, disrupting it.

The new Department of Defense started its organizational learning and innovative maritime technology knowledge at zero (i.e., 1794 in the context of this paper) while "supervising" a supremely progressive, technologically sophisticated maritime organization with 153 years of maritime technology and organizational learning, as presented here. Argote's organizational learning model of migrating knowledge into the new organization by moving people and tools into it was negated because few U.S. Navy people were assigned to the new Defense Department, and the new organization did not use the Navy's existing engineering toolsets. The details of the new structure are beyond the scope of this work, but its learning behaviors in the maritime domain, distinct from the U.S. Navy's, have been clearly demonstrated to be destructive in the extreme.

By the 1960s, the Defense Department had fully embraced the then-new, rationalist Product Development Model, which focuses on the product first and then shifts to selling the product to the customer (Blank, 2020).

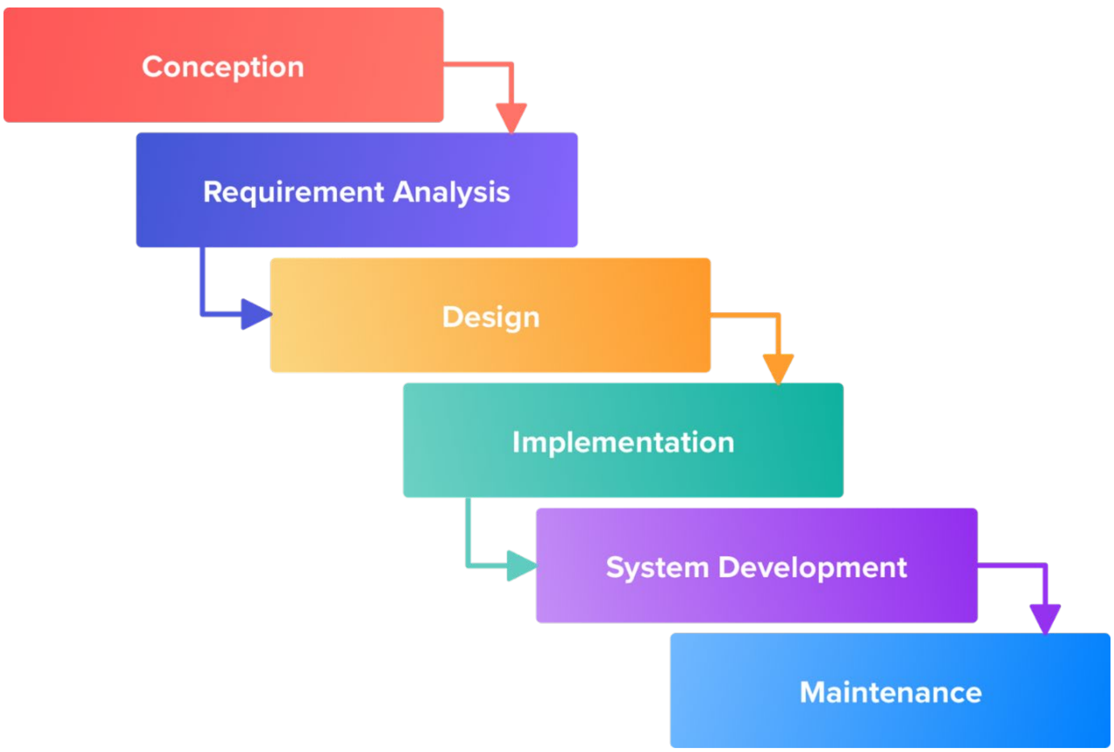

Figure 4: The Product Development Model

This model, reflecting Brooks's rationalist approach to design, assumed that designers, engineers, and scientists were perfect, fully understood the problem, and could thus deliver a perfect product. Failures were ascribed to the customer's failure to appreciate the perfection of the design.

Blank's euphonious epiphany (and later by Reis and many others) was that existing customers do not inherently accept innovative technology. Even less so when it is delivered whole and unchangeable. Moreover, technology developers do not know what customers want or will accept. Customers know what they use today and may not understand the utility of innovative technology without preparation and discovery (Blank, 2020). As one wag recently quipped, "Well, nobody wanted an iPad until they saw an iPad" (Murray, 2024).

That is also the premise of Phase II of Denning and Dunham's PIP discussed earlier. Simply inventing an innovative technology is insufficient to bring it to market (or, in our case, Fleet operation); a high level of adoption preparation and customer awareness is required to adopt a new product successfully. PIP Phase III is an essential element of success. That is also the essence of Brooks's empirical design method, Blank's Customer Development Model, and today's BML models: designers and engineers are flawed and have imperfect knowledge. So, they develop imperfect products that must be iterated to improve them. Prometheus must be unbound; knowledge must be proliferated.

Of note, the PIP Phase III attributes are absent from the Product Development Model and the Department of Defense's implementation. Leadership, executing, and embodying are replaced by procedure, analysis, and direction, leading, as it soon became apparent, to dysfunctional organizational behaviors.

While the new Department of Defense had negligible impact on the U.S. Navy's innovative technology innovation work for more than 15 years, the arrival of a new Secretary of Defense in the Kennedy administration changed that relationship. Robert S. McNamara came into his new job as a card-carrying Brooks rationalist. He led a "Whiz Kids" team that would fix the Defense Department and the Defense industrial base (Oliver & Toprani, 2022). It became almost impossible to field an *exploring* technology; nonetheless, the current 4IR U.S. Navy technology and engineering organizations have proven themselves skilled at introducing *exploiting* technologies into existing 3IR platforms as part of a viable and effective *exploitation* process in lieu of adopting thwarted 4IR replacement technologies.

	Vintage	**Replacement 4IR Platform**	**Replacement 4IR Vintage**	**Replacement Outcome**	**Duration of the 3IR Platform (In Years)**
SSN-688 Los Angeles Cass Submarine	1970	SSN-774 Submarine	1998	Adopted (But 688s are Still in Service)	54 plus
FFG-7 Frigate	1973	Littoral Combat Ship	2007	Adopted, curtailed at 22 Ships	42
FFG 7 Frigate	1973	FFG 62 Frigate	2022	In Design and first hull under construction	42
F-18 Strike Fighter	1974	F-35	2001	F-35 Curtailed, (But F-18s Still in Service)	50 and still in service
F-18 Strike Fighter	1974	MQ-25	2018	Not Adopted	Replacement Failed
CG 47 Cruiser	1975	CG(X)	2008	DDG 51 Flight III Upgrade, instead (But CG 47s are Still in Service)	49 and still in service

DDG 51 Aegis Destroyer	1981	DDG-1000	2000	Cancelled. Three ships commissioned	Replacement Failed
DDG 51 Aegis Destroyer	1981	DDG(X)	2020	Under Consideration	43 and still in production
SSN 774 Virginia Class Submarine	1998	XLUUV	2017	Not Adopted	26 and still in production
P-8 Maritime Patrol	2003	MQ-4	2021	Adopted	18

Figure 5. Thwarted 4IR *Replacement* Technologies

What Does "Good" Look Like in the 4IR? The most successful innovative technology adoption in the 4IR U.S. Navy is "Task Force 59." Started in September 2021 by the U.S. Navy's Fifth Fleet, based in the Persian Gulf, the unique *empirically* defined Customer Development Model organization adopted a BML strategy to introduce 4IR drone and artificial intelligence (AI) technology into that Fleet's operations as quickly as possible. Like the Ironclad Board, submarines, BuAer, and other U.S. Navy cold-start innovative technology organizations, TF 59 went directly to industry for innovative technology (Helfrich, 2023).

TF 59 built a new learning organization following Linda Argote's model: picking new people who learned about drones and AI, then developed new tools and tasks to field those innovative technologies. The result is a proper 4IR learning organization that has fielded a compelling suite of 4IR technologies that successfully addresses a genuine Fleet operational concern in less than two years (Helfrich, 2023). The U.S. Navy's Fifth Fleet PIP Phase III leadership and leadership methods operated in the finest traditions of the 2IR and 3IR Navy.

As of this writing, the U.S. Navy and the Department of Defense are 25 years into the 4IR. At this point in the 2IR (1894), the U.S. Navy had broken the shackles of their post–Civil War Dark Ages, fielded a New Steel Navy, and iterated it once to build a battleship Fleet. At this point in the 3IR (1974), the U.S. Navy had adopted nuclear power, fielded strategic ballistic missiles, jet airplanes, and guided missiles, and started the adoption process for software-defined radars. Only in the 1IR do we see no progress in adopting innovative technologies by 1800; Fulton's first steamship was still seven years into the future. Must the U.S. Navy repeat the same lag in adopting 4IR technologies as they did for adopting 1IR technologies?

In his prepared Congressional Statement in April 2018, Eric Schmidt said that "even the most senior leaders described responsibilities being so intricately nested across the organization that a sense of true ownership proved elusive to them. Early on, I reached a fundamental conclusion that has been borne out over time: DoD does not have an innovation problem; it has an innovation adoption problem" (Schmidt, 2018). Schmidt's clearly stated vital point was that leadership was ineffective, resulting in failed adoption events.

Conclusions

The 4IR has not been kind to the U.S. Navy. Its performance today most closely follows the pattern of the new U.S. Navy during the 1IR, where an organization that is unskilled at adopting innovative technology struggles to learn how to manage *exploring* technologies. As compensation, it becomes adept at enhancing the existing force structure by *exploiting* innovative technologies. For the 1IR, steam engines are added to sailing ships. Shell and rifled guns are installed on wooden sailing ships. Propellors replace paddlewheels on wooden steamships. Only the crisis of war opens the path to adopting ironclads, an *exploring* technology. However, as soon as the crisis passed, the U.S. Navy returned to its pre-war force structure. The 4IR U.S. Navy exhibits these same 1IR regressive, conservative, hesitant, self-doubting, and cautious behaviors. New radars are added to old ships. Old airplanes get limited design refreshes. Tired hulls, airframes, and propulsion plants are extended in service because no modern replacements are being built. The U.S. Navy has lost its technology adoption knowledge, skills, and abilities in the fourth industrial revolution. Prometheus is truly bound again. U.S. Navy leaders, exercising leadership, must change organizations, change people, and unbind Prometheus to bring the U.S. Navy into the 21st century and return them to being "A Navy Second to None."

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