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Optimizing Design Thinking for Innovation and Risk-Taking: Empirical Lessons from the U.S. Sea Services

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Optimizing Design Thinking for Innovation and Risk-Taking: Empirical Lessons from the U.S. Sea Services

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Abstract

Recent directives from the Department of Defense emphasize sweeping acquisition reform as critical to accelerating capability delivery for the modern warfighter. In an increasingly competitive and unpredictable geopolitical environment, the need for continuous innovation and effective risk-taking has never been more urgent, yet the challenge of operationalizing these imperatives within defense organizations remains largely unresolved. This paper investigates how design thinking is uniquely adapted and optimized within the U.S. Navy, Marine Corps, and Coast Guard (collectively, the U.S. Sea Services) to empower risk-taking and innovation. Drawing on 7 years (2019–2025) of data from workshops and surveys with practitioners, it identifies which commercial, military, and warfighter-centered design tools and methodologies are most effective and preferred by Sea Service practitioners. Collectively, these findings establish that effective innovation and risk-taking in the Sea Services depend on aligning design methods with each service's culture, priorities, and operating context. They offer a practical basis for warfighters, acquisition professionals, and industry to tailor innovation efforts for greater effectiveness and sustainability.

Keywords: military design thinking; warfighter-centered design; acquisition reform; innovation; risk-taking; U.S. Sea Services

Introduction

Recent defense acquisition directives emphasize that accelerating capability delivery is a strategic imperative rather than a discretionary improvement, placing explicit responsibility on acquisition leaders to operationalize innovation and risk-taking in support of warfighters in rapidly changing environments (DoD, 2025). In parallel, military organizations have adopted a growing family of design-oriented approaches, including military design thinking, warfighter-centered design, and commercial design thinking methods adapted for defense contexts (Auernhammer & Roth, 2021; Jackson, 2020; Micheli et al., 2019; Wrigley et al., 2021) Click or tap here to enter text.. These methods are often promoted as portable or universal solutions, but foundational studies in cognition, creativity, and design science suggest that their effectiveness will depend on how well they fit the cultures, missions, and operational realities of specific services and communities (Cross, 2006; Hutchins, 1995).

This paper argues that the U.S. Sea Services (the Navy, Marine Corps, and Coast Guard) can accelerate warfighting capability delivery by optimizing design-oriented practices for the branches, communities, and problem types that actually use them, rather than importing a universal design doctrine. The empirical case rests on two linked claims. First, the published military design thinking literature is not representative of Sea Service practice; it is dominated by a doctrine-focused lineage associated with systemic operational design and related constructs (Headquarters Department of the Army, 2010; Sorrells et al., 2005; Wrigley, Mosely, et al. 2021; Zweibelson, 2013, 2015, 2023). Second, Sea Service practitioner data reveal three dominant design orientations: Doctrine, Product, and Process. These orientations have distinct implications for innovation and risk-taking in acquisition and operational contexts.

The argument proceeds in four steps. The paper first summarizes the prior doctrinal framing of military design thinking and situates Sea Service innovation practices within that conversation. It then outlines two evidence streams: a bibliometric analysis of military design writing and a survey-based analysis of Sea Service design practitioners. The findings identify gaps in the existing literature and map Sea Service practitioners into Doctrine-, Product-, and Process-oriented clusters. The discussion translates these findings into practical guidance for matching design approaches to service culture and problem type to support responsible risk-taking and faster capability delivery.

Why This Matters for Acquisition Professionals

Acquisition executives, program managers, and warfare center leaders face simultaneous pressures to shorten development timelines, integrate emerging technologies, and manage operational risk for deployed forces (DoD, 2025). Within this environment, design-oriented methods, including warfighter-centered design and other military design-thinking variants, have become common tools for framing complex problems, generating concepts, and engaging users in participatory design (Jackson, 2020; Turner, 2017), but there is limited empirical evidence on which approaches actually support innovation and risk-taking in Sea Service contexts. Treating design thinking as a single transferable method risks both over-promising and misalignment when imported into organizations whose culture and mission differ significantly from the doctrinal settings in which much of the military design literature was developed. This tension is vividly captured in contrasting two prominent perspectives: Hughes and Girrier (2018) portrayed warfighting innovation as primarily technology-driven, observing that naval officers prioritize “tactics and technology (as) two sides of the same coin,” with a cultural bias toward hardware innovation and rapid adaptation in maritime domains. By contrast, Zweibelson (2013) emphasized design’s role in navigating irreducible complexity through frame awareness and systemic problematization, while critiquing rigid planning’s failure to handle “ill-structured problems” in dynamic conflicts, echoing Army-focused doctrine that favors deliberate, reflective sensemaking over iterative prototyping.

The key question is not whether military design thinking methods are useful in the abstract, but how they should be selected, adapted, executed, and evaluated so that they reliably produce innovations that matter to warfighters and are compatible with defense acquisition realities. This paper contributes to that question in three ways. It empirically demonstrates that the visible military design-thinking literature underrepresents Sea Service innovation work and overrepresents doctrine-focused constructs. It maps Sea Service practitioners into coherent design orientations that differ across branches and roles. It also derives practical implications for structuring innovation portfolios and risk-taking initiatives that leverage those service-branch and mission-specific orientations rather than work against them.

Prior Framing and Gaps Addressed

Existing military design-thinking literature is disproportionately doctrine-focused and rooted in a narrow lineage of authors and concepts, while Sea Service design work is more often expressed through innovation, prototyping, and practice-oriented adaptation. Systemic operational design, U.S. Army Design Methodology, and related constructs have been codified in doctrine and professional military education, emphasizing staff-level sensemaking, conceptual planning, and the treatment of campaigns as complex adaptive systems (Headquarters Department of the Army, 2010; Sorrells et al., 2005; Zweibelson, 2013, 2015, 2023; Zweibelson et al., 2020, 2021). These works are foundational for understanding how some communities in the Army, Special Operations, and allied forces think about design, but they provide only a partial view of design practice across the broader U.S. military.

Sea Service design work often appears under different labels and in different venues. Case studies such as Project Athena aboard USS *Benfold* and Tactical Advancements for the Next Generation (TANG) document initiatives in which officers and enlisted personnel use design-thinking tools to prototype technologies, reframe tactical problems, and change local processes (Cannon, 2014; Jackson et al., 2014; Turner, 2017). Warfighter-centered design and related efforts at the U.S. Naval Postgraduate School (NPS) and other innovation hubs emphasize fleet-relevant problem selection, user engagement, and iterative experimentation rather than doctrinal synthesis alone, an approach that is aligned with, but distinct from, commercial engineering and design practices (Gero & Milovanovic, 2020; Mabogunje et al., 2016)Click or tap here to enter text.. The gap this paper addresses is therefore not the presence or absence of design thinking in the military, but the mismatch between a doctrine-heavy published lineage and the more varied practice ecology observed in the Sea Services. This matters because practitioner data, collected across 7 years of design and innovation workshops, expose a prototyping/risk-taking ecology that is primed for rapid capability delivery, yet misaligned with, or unaware of, “military design thinking” doctrine.

Methods

A mixed-method research design was used to connect how military design is written about with how it is actually practiced in Sea Service innovation settings. The first phase was a bibliometric analysis of 67,398 documents from NPS, the U.S. Army Command and General Staff College (CGSC), and the Combined Arms Research Library (CARL), spanning theses, monographs, field manuals, and related publications through 2022. Using and extending the search strategy developed in previous military design thinking research (Wrigley, Mosely, et al., 2021), the analysis compared narrow queries centered on military design thinking and systemic operational design with broader queries for design thinking and adjacent innovation terms.

The second phase analyzed survey data from 154 participants in multiservice U.S. Naval Institute “DARE Innovation” Workshops held between 2019 and 2025. Participants included junior and mid-grade officers, enlisted personnel, and select civilians from the Navy, Marine Corps, and Coast Guard. They completed a research questionnaire about their use of design practices, perceived suitability of design methods at different organizational levels, and views on leadership sponsorship of design-related initiatives. The questionnaire drew on established measures of design self-efficacy and design cognition, adapted from prior work in engineering design and design thinking research (Carberry et al., 2010; Gero & Milovanovic, 2020; Micheli et al., 2019).

Principal component analysis (PCA) was used to identify latent dimensions in respondents’ design-thinking perceptions, following standard practices for dimensionality reduction in social science and design research (Abdi & Williams, 2010; Hair et al., 2009). Bartlett’s Test of Sphericity and the Kaiser–Meyer–Olkin statistic were used to verify sampling adequacy and correlation structure (Kaiser, 1970). Hierarchical agglomerative clustering with Ward’s method was then applied to the component scores to identify groups of practitioners with similar design orientations, an approach widely used in market segmentation and preference modeling (Johnson, 1967; Kaufman & Rousseeuw, 1990; Punj & Stewart, 1983; Rousseeuw, 1987; Ward, 1963). Clusters were interpreted in conjunction with demographic overlays by branch, rank, warfare domain, and functional area.

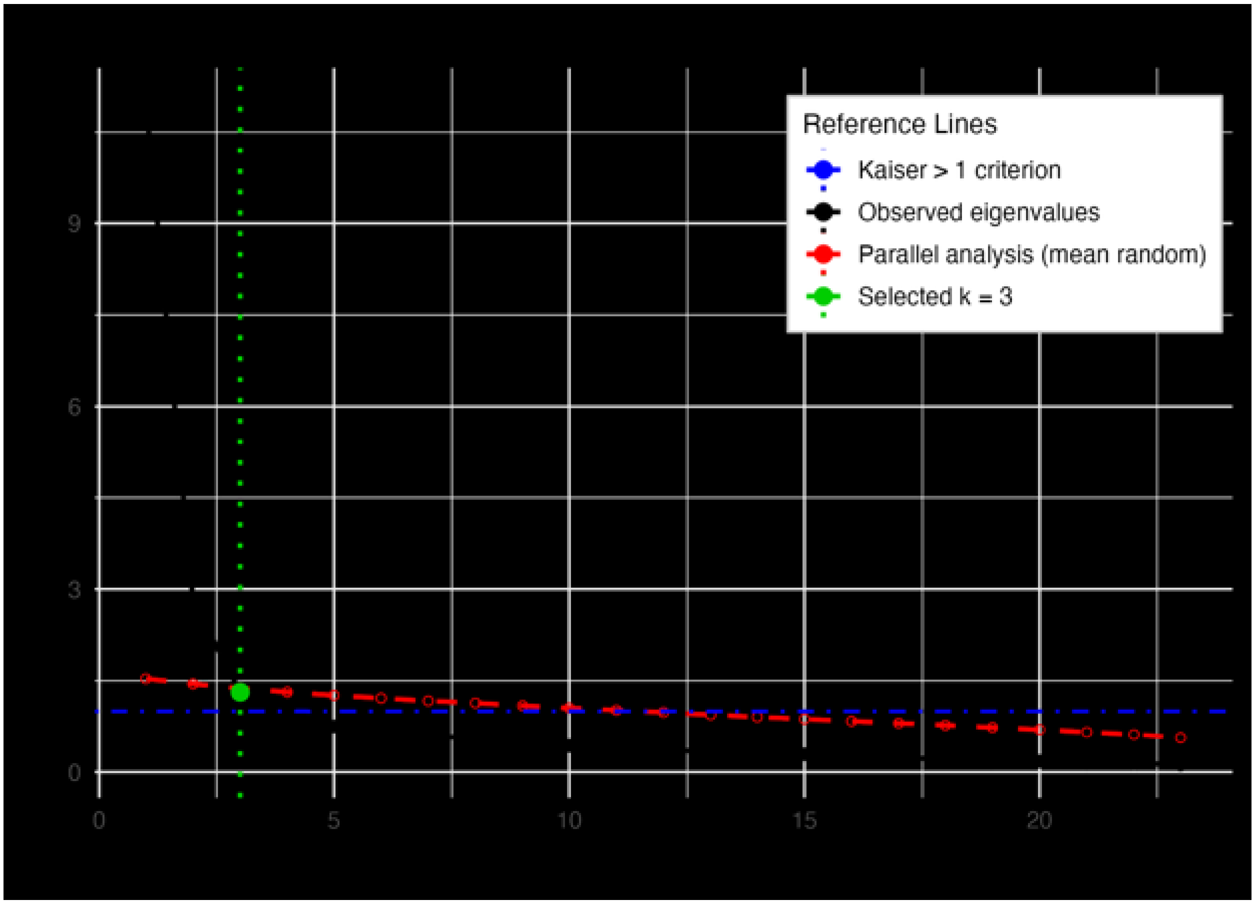

Figure 1. Scree plot and parallel analysis for principal component selection (n = 154). Three components retained (65.8% variance explained).

Research Findings

The bibliometric analysis confirmed that the visible military design thinking corpus is concentrated in a doctrine-focused lineage associated with a small set of recurring authors and concepts dominated by Army- and joint-focused theses and monographs that anchor design in doctrinal constructs such as systemic operational design, U.S. Army Design Methodology, and effects-based operations (Hayward, 2008; Nunemaker, 2016). These works emphasize staff-level conceptual planning, reframing of operational environments, and the integration of complex systems perspectives into traditional planning processes.

When the search was broadened to include "design thinking" without the "military" modifier, a different picture emerged. Additional theses and reports, particularly from NPS, documented Sea Service initiatives that used design thinking tools for technology prototyping, human–machine interface design, and local process innovation, often without labeling themselves as "military design thinking" (Cannon, 2014; Christiansen, 2016; Hall, 2012; Johnston, 2014; Laplante, 2015; McCarthy, 2021; Wieser, 2020; Wyckoff, 2015). These works foreground user-centered ideation, iterative experimentation, and cross-functional collaboration, themes that are largely absent from the doctrine-focused lineage. The bibliometric findings therefore suggest that taking the narrow military design corpus as representative of design practice in the Department of Defense risks overlooking substantial Sea Service work on product innovation and process experimentation.

Practitioner Insights

Survey data from U.S. Naval Institute "DARE Innovation" Workshops provide a complementary view of how practitioners in the Sea Services understand and apply design methods. Principal component analysis of the survey items revealed three dominant dimensions of military design activity: Doctrine, Product, and Process. The Doctrine dimension captured systems-level framing, visualization of operational approaches, and multi-actor analysis: elements consistent with doctrinal design constructs and staff-level planning practices. The Product dimension reflected technology and interface innovation, including developing new capabilities, designing user interfaces, and creating human–machine interfaces, aligning more closely with industrial and interaction-design. The Process dimension captured iterative engagement with the operating environment, experimentation and prototyping, and the co-evolution of problem and solution, echoing process-oriented views of design cognition and exploration.

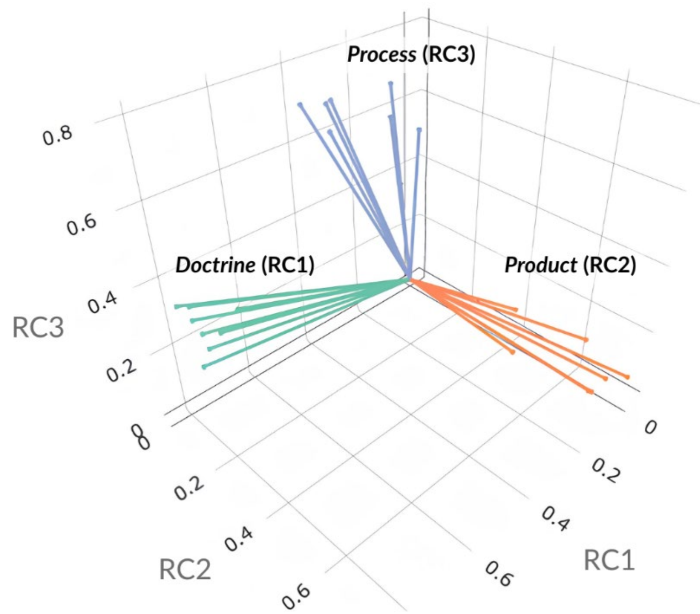

Figure 2. Rotated component structure for military design thinking survey items: Doctrine (RC1, green), Product (RC2, red), Process (RC3, blue).

Hierarchical clustering of respondents in this three-dimensional space produced four interpretable practitioner archetypes: Generalists, Doctrine-Focused, Product-Focused, and Process-Focused designers. Generalists scored moderately on all three dimensions and were especially common in Coast Guard participants, reflecting that service's broad, multi-mission demands with limited resources for deep specialization. Doctrine-Focused practitioners scored highest on the Doctrine dimension and were disproportionately represented among Navy participants in warfare and staff billets, suggesting an orientation toward doctrinal synthesis and large-scale integration. Product-Focused practitioners scored highest on the Product dimension and were more common among Marine Corps officers and certain Navy communities engaged in capability development and experimentation. Process-Focused practitioners scored highest on the Process dimension and appeared more often in planning, intelligence, and innovation roles that emphasize exploratory analysis and iterative adaptation.

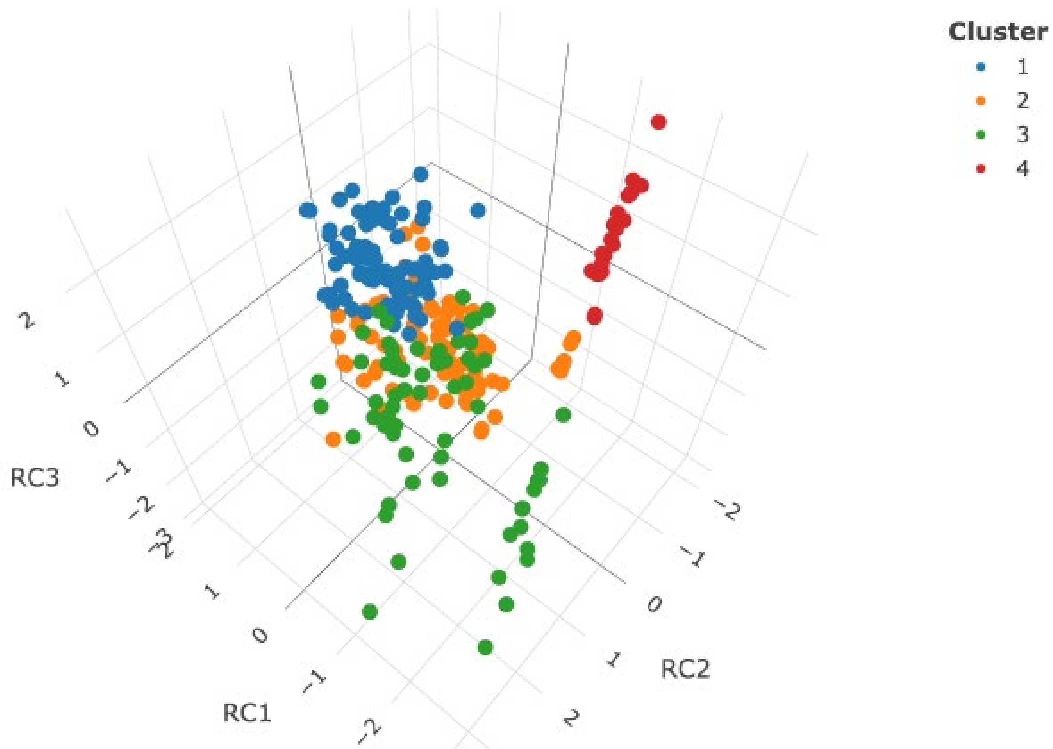

Figure 3. Practitioner clusters in Doctrine-Product-Process space (n = 154): Generalists (blue), Doctrine-focused (orange), Product-focused (green), Process-focused (red).

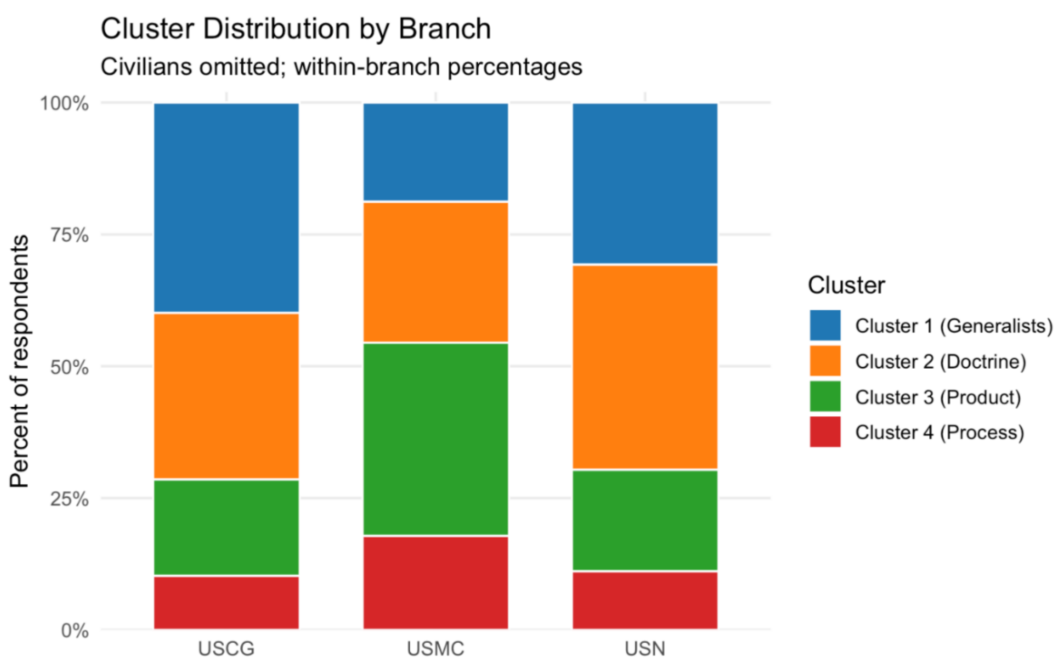

Figure 4. Cluster membership by Sea Service branch: USCG generalist-heavy, USMC product/process, USN doctrine-heavy.

Demographic overlays by rank, warfare domain, and functional area further illustrated that design orientations are shaped by institutional context. Officers were more likely than enlisted personnel to fall into Product-Focused clusters, consistent with their greater exposure to acquisition pathways and technology initiatives. Surface and aviation communities showed stronger Doctrine scores, aligning with procedure-intensive environments. Cyber and information-technology personnel, by contrast, often appeared as Generalists or Process-Focused practitioners, reflecting more fluid problem spaces and the need for continuous experimentation. These patterns support the view that design and innovation in the Sea Services, and by extension the Department of Defense, is not monolithic but organized into distinct, culturally situated orientations.

Innovation and Risk-Taking Implications

The combined bibliometric and practitioner findings have direct implications for how acquisition and operational leaders should structure design-oriented innovation and risk-taking. First, they suggest that military design methods should be treated as a portfolio of Doctrine-, Product-, and Process-oriented practices rather than a single transferable method. Program executives, managers, technical directors, chief engineers, and other practitioners might then ask: What elements of this portfolio should be used, and with what teams, to drive and accelerate capability development with design thinking? Building on our PCA results, we can offer tangible and targeted recommendations.

Doctrine-oriented design is most valuable when the primary challenge is sensemaking, alignment, and integration across large organizations and campaigns, such as developing new concepts of operations or integrating emerging technologies into existing force structures. Specific recommendations for aligning optimal design tools with Doctrine-oriented designers are shown in Table 1.

Table 1. Doctrine-Oriented Design Tool Alignment summarizes RC1 factor loadings above 0.5 and pairs each one with a Doctrine-Focused affinity and example tools or methods.

RC1 loading	Doctrinal Affinity	Why it fits doctrine communities	Example tool or method
0.834	Process Improvement	Supports improving operational, logistical, business, or administrative processes.	Process mapping, after-action review, workflow redesign (Wrigley et al., 2021).
0.819	Multi-Actor Analysis	Fits critical analysis across commanders, staff, partners, and affected stakeholders.	Multi-actor analysis, stakeholder mapping, red-team discussion (Wrigley et al., 2021).
0.806	Generation of Alternatives	Supports deliberate generation and comparison of multiple courses of action.	Alternative generation, concept sketches, course-of-action development (Cross, 2023; Wrigley et al., 2021).
0.788	Tolerance of Ambiguity and Failure	Matches doctrine to operations under uncertainty and with incomplete information.	Framing exercises, ambiguity mapping, reframing prompts (Wrigley et al., 2021).
0.787	Civilian-Centered	Reflects attention to stakeholders and non-military context.	User/stakeholder interviews, empathy exercises, context analysis (Micheli et al., 2019; Cross, 2023).
0.782	Operational Approach Representation	Translates doctrine to military operations planning.	Narrative, graphic concept, commander’s intent visualization (Wrigley et al., 2021)

0.761	Visualization	Supports making complex situations legible for command and staff.	Sketching, systems diagrams, visual sensemaking, concept boards (Cross, 2023; Wrigley et al., 2021)
0.744	Interdisciplinary Collaboration	Supports collaboration across functions and expertise areas.	Cross-functional workshops, facilitated synthesis sessions (Micheli et al., 2019; Wrigley et al., 2021).

Product-oriented design is best suited to capability development, prototyping, and human–machine interface design, particularly in Sea Service communities responsible for platforms, payloads, and complex systems. Table 2 provides targeted recommendations for design tools best suited to serve these communities.

Table 2. Product-Oriented Design Tool Alignment summarizes RC2 factor loadings above 0.5 and pairs each one with a Product-Focused affinity and example tools or methods.

RC2 loading	Product Affinity	Why it fits product communities	Example tool or method
0.760	Creativity	Strongly supports creative agency and novel solution generation.	Brainstorming, ideation, creative reframing (Wrigley et al., 2021).
0.754	Innovation	Aligns with developing new technologies and products.	Concept development, innovation workshops, opportunity framing (Micheli et al., 2019; Wrigley et al., 2021).
0.745	UI/UX/HMI	Directly supports designing user interfaces, user experience, and human-machine interfaces.	Prototyping, journey maps, interface sketching (Micheli et al., 2019; Wrigley et al., 2021).
0.745	User Centered	Emphasizes user needs, involvement, and empathy.	Ethnographic methods, personas, user interviews (Micheli et al., 2019; Cross, 2023).
0.681	Complex & Adaptive	Fits complex and adaptive problem spaces that require flexible design responses.	Framing exercises, systems mapping, design workshops (Wrigley et al., 2021).
0.533	Problem Framing	Supports initial problem definition and reframing before solution work.	Reframing prompts, problem statements, wicked problem framing (Cross, 2023; Wrigley et al., 2021).
0.505	Goal Analysis	Helps clarify desired outcomes and desired state.	Goal analysis, target-state mapping, success-criteria workshops (Cross, 2023).
0.760	Creativity	Strongly supports creative agency and novel solution generation.	Brainstorming, ideation, creative reframing (Wrigley et al., 2021).

Process-oriented design is most appropriate when organizations must learn their way into new problem spaces through experimentation, wargaming, and rapid-cycle iteration. Design thinking practices adapted for these Process-driven organizations are highlighted in Table 3.

Table 3. Process-Oriented Design Tool Alignment summarizes RC3 factor loadings above 0.5 and pairs each one with a Process-Focused affinity and example tools or methods.

RC3 loading	Process Affinity	Why it fits process communities	Example tool or method
0.803	Co-evolution of problem, solution	Fits processes where problem definition and solution development evolve together.	Iterative reframing, process mapping, abductive reasoning (Cross, 2023; Wrigley et al., 2021).
0.762	Systems Thinking	Matches process work that treats the environment as interdependent and dynamic.	Systems mapping, causal loops, workflow diagrams (Wrigley et al., 2021).
0.750	Iterative Refinement	Directly supports continuous refinement through repeated cycles of action and learning.	Iteration cycles, prototyping, test-and-learn loops (Micheli et al., 2019; Wrigley et al., 2021).
0.731	Solution Development	Emphasizes translating analysis into a workable sequence of actions.	Course-of-action development, decision gates, solution sketching (Cross, 2023; Micheli et al., 2019).
0.728	Prototyping	Supports using small experiments to improve the process before scaling.	Prototypes, pilot runs, sand-table exercises (Micheli et al., 2019).
0.700	Force Design	Fits the design of structures, roles, and capabilities as a process.	Capability mapping, organization design, force structure analysis (Wrigley et al., 2021).
0.685	Collaboration	Strong fit for team-based processing and shared sensemaking.	Workshops, structured discourse, collaborative synthesis (Wrigley et al., 2021).
0.582	Operations Planning and Design	Directly aligns with planning as a formal, repeatable process.	Mission analysis, planning cycles, operational design routines (Wrigley et al., 2021).

Next, the findings suggest that responsible risk-taking is more feasible when design efforts are aligned with existing practitioner orientations rather than imposed against them. For example, a doctrine-heavy innovation initiative in a community whose practitioners are predominantly Product- or Process-Focused may be perceived as abstract or disconnected from technology and operations, reducing engagement and diminishing credibility in processes that warfighters and technologists alike might perceive as “buzzwords” or “boondoggles” (Cross, 2023; Hirsch & Levin, 1999). Conversely, narrowly scoped prototyping sprints in communities dominated by Doctrine-Focused practitioners may fail to address the higher-level integration and policy constraints that determine whether innovations can scale, producing the appearance of progress without enduring capability gains, what some defense commentators have described as “innovation theater” (Harrison, 2023). Mapping branches, units, and functional areas to their prevailing design orientations can help leaders choose appropriate design modes, set realistic expectations about risk and learning, and allocate sponsorship and resources accordingly.

Finally, the evidence underscores the importance of warfighter-centered design as a bridging vocabulary and practice for the Sea Services. Warfighter-centered design emphasizes user engagement, context-specific problem framing, and iterative refinement of concepts and prototypes, especially in collaboration with operators (Venturi & Troost, 2005). Framed in Doctrine-Product-Process terms, warfighter-centered efforts can be seen as integrating doctrinal understanding of missions, product-level focus on capabilities and interfaces, and process-level exploration of employment concepts and organizational routines. For acquisition organizations charged with implementing innovation and risk-taking directives, this integrated framing can help translate abstract guidance into concrete, service-tailored practices.

Conclusion

The analysis in this paper leads to three central conclusions for the acquisition community. First, the current military design thinking literature on innovation, anchored in theory-heavy doctrinal constructs, does not fully capture the innovation- and experimentation-oriented work occurring in the U.S. Sea Services. Second, survey data from Sea Service practitioners show that military design thinking in these communities is best understood as a portfolio of three orientations (Doctrine, Product, and Process) that vary by service branch, leadership role, warfighting domain, and organizational function. Third, acquisition and operational leaders can accelerate warfighting capability delivery and structure more effective risk-taking by deliberately matching design modes to service culture and problem type, rather than treating design thinking and design-driven innovation as a universal doctrine or drop-in toolkit.

For acquisition professionals, the practical recommendation is straightforward. When planning innovation and risk-taking initiatives, the central question should not be “How might we innovate?” but rather “Which design orientations (Doctrine, Product, Process) fit this problem, this community, and this phase of capability development?” By drawing on the Sea Services’ own empirically observed design orientations and on adjacent warfighter-centered design practices, defense organizations can better align innovation methods with warfighter needs, acquisition realities, and the cultural ethos of their forces. In doing so, they move closer to fulfilling the promise of acquisition reform: delivering meaningful capabilities to warfighters faster, with clearer understanding of the risks and opportunities involved.

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