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NWSI Mission

The mission of the Naval Warfare Studies Institute (NWSI) is to coordinate NPS inter-disciplinary research and education in order to accelerate and enhance naval warfare concept and capability development.

Executive Summary:

- NWSI hosted two Seapower Conversations in August, “HYBRID FORCE 2045: A Vision of Future Aircraft Carrier Warfighting” and “Intermediate Force Capabilities (Non-Lethal Weapons)”.
- The Warfare Innovation Continuum Workshop “Hybrid Force 2045” registration deadline is 16 September.
- 2020’s WIC Workshop “Resurrecting War Plan Blue” Executive Summary is now available.
- Joint Interagency Field Experimentation held its final FY21 exercise from 23-27 August.

RESEARCH TASK FORCES:

In FY22, NWSI will establish research task forces to provide coherence for completed and ongoing research, to identify concept and capability gaps, and to encourage focused, interdisciplinary research and education collaboration. Task Force OVERMATCH was established in FY21 to support Naval Operational Architecture / Project OVERMATCH efforts. Following the Warfare Innovation Continuum Workshop in September, Task Force HYBRID FORCE will be established to explore the numerous issues surrounding the use of intelligent autonomous systems and manned/unmanned teaming as part of a naval force. Shortly after, NWSI will conduct another WIC Workshop to initiate Task Force GRAY ZONE. Task Force GRAY ZONE will coordinate research, education, and other actions and activities related to competition below the threshold of war.

CRITICAL THINKING & JUDGEMENT:

[1. Cultivating Critically Thinking Strategic Leaders: Season 2 of Critical Thinking for Strategic Leadership Course at Naval Postgraduate School.](#)

This summer quarter (Jul-Sep) elective course offering has been met with great interest from students from different schools and departments. Fifty students from three different schools across campus (and around ten different curricula / programs), students have discussed topics such as traits, skills, and attitudes of people who are noted critical and strategic thinkers.

2. Maneuver Warfare for the Mind: The Art and Science of Interdisciplinary Learning for Innovation and Warfighting Leaders.

General Mattis noted that the most important six inches on the battlefield is between your ears. This elective course offered in NPS' fall quarter (Oct-Dec) will focus on developing the central muscle between our ears (our minds) and introduce how to use the art and science of learning to improve warfighter skills, attitudes, and ultimately readiness in the context of current strategic documents, concepts, and warfighter problems.

EMERGING TECHNOLOGIES:

3. Xerox's first 3D printer lands at the Navy Postgraduate School.

Additive manufacturing has the potential to literally revolutionize how the military supplies its forward-deployed forces. Driven by this belief, the Naval Postgraduate School and Xerox agreed to collaborate on advancing additive research, specifically metal 3D printing. As part of a Cooperative Research and Development Agreement (CRADA), NPS took delivery of the first commercial ElemX which is already being considered for installation aboard one of Third Fleet's ships.

WARGAMING:

4. Mobile Education Teams.

The NWSI Wargaming Center Mobile Education Team (Profs Jeff Appleget and Rob Burks) just completed two weeks of wargaming workshops for the NATO/EU Hybrid Centre of Excellence (HCOE). These workshops, unique within the DoN, teach participants how to design, develop, and deliver military wargames that enable organizations to better understand, and to employ, the art and the science of war.

CONCEPT GENERATION & DEVELOPMENT:

5. Warfare Innovation Continuum (WIC) Workshop – “Hybrid Force 2045”.

The WIC Workshop is scheduled for 20-23 Sept 2021 as a Naval Postgraduate School Thesis & Research Week activity to apply emerging technologies to shape the way we fight. This WIC Workshop will explore how the Navy and Marine Corps might benefit from the integration of robots and drones into their formations as well as the many considerations that come with this new capability.

6. War Plan BLUE WIC Executive Summary.

The 2020 WIC effort explored topics similar to the original pre-WWII War Plan BLUE. War Plan BLUE was a plan for how the United States would need to prepare for war, go to war, and sustain a war. Like its namesake, this WIC examined forward defense of critical ports and bases, resilience in force structure, and robust industrial logistics support. The full executive summary report of the FY20/21 Warfare Innovation Continuum titled “Resurrecting War Plan Blue” is available for CAC holders and can be found on NWSI's website.

7. Joint Interagency Field Experimentation (JIFX) 21-4.

Joint Interagency Field Experimentation (JIFX) completed the final 2021 exercise from 23-27 August at the SLAMR Aquatic Facility at the Naval Postgraduate School in Monterey, California and concurrently at McMillan Airfield at the Camp Roberts Army National Guard Base.

MISCELLANEOUS:

8. Seapower Conversation: HYBRID FORCE 2045: A Vision of Future Aircraft Carrier Warfighting.

On 5 August 2021, CAPT Robert C. “Barney” Rubel, USN (Ret.) shared his wealth of knowledge with more than 60 attendees on MS Teams and the NPS Watch Live website as he discussed HYBRID FORCE 2045: A Vision of Future Aircraft Carrier Warfighting.

9. Intermediate Force Capabilities (Non-Lethal Weapons).

On 18 August 2021, Col. Wendell B. Leimbach (USMC) Director, Joint Intermediate Force Capabilities Office discussed the challenge our forces face at the threshold below armed conflict around the world with more than 50 attendees on MS Teams and the NPS Watch Live website.

10. Scheduling Ship Maintenance Jobs in Multiple Ports to Minimize Workload Fluctuation.

ENS S. Naldo (USN) published the above titled thesis recognized as outstanding by the Operations Research Department of the Naval Postgraduate School. ENS Naldo explored the opportunities of utilizing multiple ports to support planned and unplanned pier-side maintenance.

CRITICAL THINKING & JUDGEMENT:

1. Cultivating Critically Thinking Strategic Leaders: Season 2 of Critical Thinking for Strategic Leadership. Mie Augier & William F. Mullen

Supporting the development of critical and strategic thinking skills for warfighting leaders, season 2 of the course which took off last year, is well underway. With fifty students from 3 different schools across campus (and around 10 different curricula / programs), students have discussed topics such as traits, skills and attitudes of people who were able to think critically and strategically; the importance of interdisciplinary and holistic problem-solving skills; aspects of the foundational literatures on how to cultivate it; and using thinking to understand and lead in situations involving wicked problems. See more about season 1 [here](#).

While not providing a summary of all discussions or the course content, brief mention is made of a few of the big themes and how they are developed to try and make our class relevant and support NPS moving beyond industrial age thinking. Details include the need for interdisciplinary range and integrative approaches, how we teach along with a description of the richness of our diverse student body and how they mix and interact in class.

-Interdisciplinary and integrative approaches and problem solving. A big theme in the course is the need for interdisciplinary and integrative (problem driven) approaches. What is important here is that interdisciplinary doesn't mean applying one's favorite tool or analytical approach to a few different areas; to be interdisciplinary one needs to cultivate insights from different perspectives and integrate and synthesize them to further a broad understanding. This has always been important but increasingly so in times of rapid change as future leaders can't just rely on sharpening existing hammers (looking for nails) as future problems are likely to be very different than current ones. The course examines some pitfalls in analysis and thinking and the need to cultivate broad synthesizing skills and intellectual 'range' in the context of warfighter issues. As Air Force 1stLt, Kevin Peaslee, noted: "Critical Thinking for Strategic Leadership has come to the forefront as the Great Power Competition is ever-evolving. [The course uses] different perspectives, theories, and frameworks (e.g., RANGE, The Real OODA Loop, Andrew Marshall's Net Assessment, Van Riper's Strategic Leadership perspectives & many more).

The Critical Thinking for Strategic Leadership class allows future-thinking military leaders to immerse themselves in a critical strategic mindset to capitalize on winning opportunities, negate vulnerabilities, and, most importantly, to outthink an opponent."

-To get beyond the industrial age paradigm and embrace postindustrial age education, we need to change not just what we teach, but also how we teach it. Our course embraces active learning approaches, including cases and small group discussions, and in most classes we use one (or fewer) power point slides (remembering what Mattis noted power point does to us -- [General Mattis, save the U.S. military. Ban PowerPoint.](#)). While giving up power point makes it less easy to fit a class into a neat plan or to control the discussion, it helps enable student led discussions (with teachers adapting to student discussions, not the other way around) and a culture where teachers learn with and from the students as much as the other way around. Active learning is a key aspect of postindustrial age education which required moving beyond rote learning and memorization of facts, and towards cultivating thinking. As LT Morggan O'neil (USNR), noted: "To borrow the concept from Einstein, "Education is not the learning of facts, but the training of the mind to think." In today's world of increasing technology development, the lure is to 'learn more'. Through case study, historical examples, and scrutinizing discussions, we discover how others before us have engaged in critical thinking – or failed to engage in critical thinking. We rediscover that our greatest strength lies in our ability to learn not, "what to think, but HOW to think" – which transfers to our leadership and strategic thinking in all endeavors as military leaders"

-A third point that supports the development of critical thinking and judgment skills needed for future leaders is a broad interdisciplinary learning environment, as President Rondeau noted [Future Military Leaders Need Interdisciplinary Educations | Proceedings - January 2020 Vol. 146/1/1,403 \(usni.org\)](#). We are very fortunate to have students from three different schools on campus, and a variety of different programs, as each bring a set of unique experiences and perspectives which enrich the learning environment. We also try and integrate both conceptual / scholarly ideas and warfighting perspectives and application within each class. Maj. Alfred Cannin (USAF) captured this:

“NPS’s standing policy allows students to participate in any class offered within any school through the Monterey campus. Although true, this opportunity often goes unused.” “Partially driven by the benefits of COVID distance learning requirements, three influences shaped a meaningful online classroom experience: tailored curriculum that fostered interdisciplinary analysis of current events and relevant historical cases, co-led by an instructor team that blended the practicality of a highly experienced professor with the recency of a retired general officer perspective, and a purposely blended cross-school student mix of US, ally, and civilian students with diverse operational and support backgrounds.”

As the course wraps up in the next weeks, we are fortunate to have been able to learn with (and from) an outstanding group of NPS students. They are our future;

2. Maneuver Warfare for the Mind: The Art and Science of Interdisciplinary Learning for Innovation and Warfighting Leaders. Mie Augier & William F. Mullen

General Mattis noted that the most important six inches on the battlefield is between your ears. This course will focus on developing the central muscle between our ears (our minds) and introduce how to use the art and science of learning to improve warfighter skills, attitudes, and ultimately readiness in the context of current strategic documents, concepts, and warfighter problems. The course, GB 4012, will focus on developing skills and attitudes for judgment and creative thinking. In keeping the emphasis on post-industrial age education and developing active minds through active learning, there will be no lectures, memorization, or “death by power point,” but rather Socratic discussions, case studies, small group discussions, exercises, and writing.

We will examine warfighter leaders and the skills, traits, and habits needed to develop agile minds and apply maneuver warfare and emerging naval operating concepts to current and future security challenges, in

and helping them think, reflect, and learn (and learn the ability to continue learning) is a great experience. Maj (USMC) Martin Thomas noted on the importance of cultivating reflection, thinking and learning skills: “As military professionals we are obligated to take the time to reflect upon our thoughts, decisions, and experiences; good or bad. Moreover, we should be draconian in our efforts to read, research, and study strategy, warfare, and critical thinking. In doing so, we can prepare for future opportunities to lead and influence those under our charge, and it enables us to build a level of intuition that assists in future decision-making and the management of successful teams.”

See the full course description [here](#).

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order to improve our learning cultures, readiness and maintain our national competitive advantage.

This course is particularly useful for students interested in the importance of learning to their profession and/or those who are working on thesis topics related to Force Design 2030, the CPG, FMFM-1, MCDP-7, EABO, or DMO, as well as those who would like to work on a paper to submit for publication as part of the class.

See the full course description [here](#).

Recent papers:

[Sustaining Our Competitive Advantage, Thinking is Competing](#)

[Assumptionitis in Strategy](#)

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EMERGING TECHNOLOGY:

3. Xerox's first 3D printer lands at a Navy Postgraduate School

Safety is a critical feature when 3D-printing objects aboard a confined ship at sea. The ElemX doesn't use metal powders or lasers, which not only simplifies operation but reduces the danger of operating it.

As a continuation of their collaboration, Xerox and NPS are looking at the possibility of installing an ElemX printer onboard a surface ship. "We always intended to put this machine through a simulated sea state environment, but now we hope to leapfrog that requirement," said Hobson. "We have, for the very first time, a liquid metal printer that's going to operate under seagoing conditions, including motor vibrations; rolling waves; and a wide range of temperature, humidity, and air pressure.

"The data from those prints are going to be absolutely invaluable when we compare them with data from similar parts printed here in our lab," said Hobson.

WARGAMING:

4. Mobile Education Teams

The NWSI Wargaming Center Mobile Education Team (Jeff Appleget and Rob Burks) just completed two weeks (10 – 27 SEP) of wargaming workshops for the NATO/EU Hybrid Centre of Excellence (HCOE). The HCOE is the European Centre of Excellence for Countering Hybrid Threats and currently supports 29 member nations. The Director and her team reached out to the Wargaming Center to support their efforts to develop a broader understanding of hybrid warfare among all the participants through wargaming. The

"For the last several years, we've been sending ships to sea with polymer 3D printers, but an aluminum metal printer will take it up a notch," said U.S. Navy Capt. Dan Sunvold, surface warfare chair at NPS.

"By getting a liquid metal printer into the hands of the innovative sailors at sea, working on the same things that the faculty and students here at NPS are working on, they can collaborate and share in near real time the lessons learned," said Sunvold. "I think that's a huge win." The first commercial ElemX was installed in December 2020 at the Naval Postgraduate School, Monterey, Calif. Read the full article and how the project supports both collaborative research and naval service application [here](#).

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workshops focused on providing a better understanding of hybrid operations to participants. The participants then developed an education wargame focused on better educating HCOE member nations on hybrid operations. The course included 26 participants from ten different NATO and EU nations and is the first step in building a lasting relationship with NPS. Additional information is available [here](#).

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CONCEPT GENERATION & DEVELOPMENT:

5. Warfare Innovation Continuum (WIC) Workshop. Hybrid Force 2045

The WIC Workshop is scheduled for 20-23 September 2021 as a Naval Postgraduate School Thesis & Research Week activity to apply emerging technologies to shape the way we fight. This annual workshop facilitates small teams of junior officers and early career engineers through rapid concept generation using tools of design to develop concepts of operations and employment to support and enhance the future Fleet and Force. The 2021 workshop will be held on the NPS campus in Monterey with remote participation available on the NPS "Virtual Campus" via Teams.

***DESIGN CHALLENGE:** How might emerging technologies, new operational concepts, and alternative fleet designs contribute to a more effective naval force across the spectrum from competition to conflict? How do the alternative fleet designs enhance the effectiveness and resilience of joint, combined and coalition forces across all domains?*

Apply for a spot on a **Concept Generation Team**, register as an **Observer**, offer your services as a **Mentor**, or let us know you are interested in serving in a specialty role. Due to COVID-19 considerations, additional spots are only available for remote participation. Register [here](#).

6. Warfare Innovation Continuum (WIC) Resurrecting War Plan Blue.

Coordinated by the NPS Naval Warfare Studies Institute, the Warfare Innovation Continuum (WIC) is a series of coordinated cross-campus educational and research activities synchronized with a central theme of interest to the United States Navy. Its purpose is to expose NPS faculty and students to emerging naval challenges and opportunities to allow relevant warfighting education and research across campus. NPS WIC leverages classroom projects, theses, the NPS Naval Research Program and other research initiatives in advancing naval concepts, assessing new technologies, and developing tactics while enhancing our students' educational experience and sharpening their combat skills. The WIC supports the coordinated research efforts of various cross-campus events including regularly scheduled classes, workshops, Capstone Projects, and individual theses research (see Figure 1). The over-arching WIC construct facilitates a synergistic

concept development method which results in innovative ideas produced at the beginning of the continuum to be further developed as the timeline progresses. For example, some of the technical proposals and concepts proposed at the beginning of the timeline will be taken to prototyping and experimentation in the Consortium for Robotics and Unmanned Systems Education and Research (CRUSER'S) Innovation Thread. The broad focus of the 2020 WIC effort was to explore similar topics of the original pre-WWII War Plan Blue series on forward defense of critical ports and bases, resilience in force structure, and robust industrial logistics support.

From one overarching design challenge, each team will work a specialized topic. Participants are provided new technologies and possible future capabilities, then facilitators guide the teams through a design process to generate concepts of employment and risk assessments within a future conflict scenario. Teams brief their best three or four concepts to sponsors, industry executives, and senior officers on the final morning of the workshop. Results are further disseminated to technical community of interest members, Fleet commands, OPNAV staff, and DON and DoD leadership. Selected concepts seed NPS student theses, NPS faculty research, and partnerships with others in the warfare centers, academia and industry, and concepts are further developed through prototyping and testing in field experimentation.

A final report detailing process and outcomes of selected projects is released before the end of each calendar year. See the **Warfare Innovation Workshop Report Archive** currently available through the [CRUSER website](#) for access to available reports. Please visit [Warfare Innovation Workshop - NWSI](#) for more information.

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The executive summary of the FY20-21 "Resurrecting War Plan Blue" is available for CAC holders [here](#).

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7. Joint Interagency Field Experimentation (JIFX) 21-4

The JIFX team hosted 20 groups conducting 22 different experiments between NPS' two field laboratory sites located at Camp Roberts, California, and the [Sea Air Land Military Research \(SLAMR\)](#) facility adjacent to the NPS campus in Monterey, California as well as one collaborative experiment conducted via a virtual bridge linking NPS and Plano, Texas. The multi-institutional semi-structured learning environment model proved a powerful demonstration of the JIFX community's ability to optimize collaborative learning to facilitate the rapid development of capabilities.

JIFX had 247 registered participants with 84 experimenters representing 19 businesses, one DoD research lab, and two academic institutions along with 40 DoD stakeholders from the Naval Special Warfare Command, Army Futures Command, Air Force Research Lab, TRANSCOM, STRATCOM, NORTHCOM, SOCOM, and SOUTHCOM who provided feedback and mentorship to experimenters. Fifty-one NPS students participated as technology evaluators or observers, representing three US military services and the Hellenic, Swedish, Brazilian, and Indonesian navies.

A comprehensive technical report with all the experiment results, the [JVAB Cyber Vulnerability Assessments](#), and the technology evaluations will be published in early October. U.S. government personnel will access the report through the CAC enabled website found here: [JIFX - Field Experimentation \(CAC\) - Naval Postgraduate School](#).

The next event, JIFX 22-1, is scheduled for November 1 - 5. There will be a dedicated 5G network available at the SLAMR site in November to support experimentation with 5G enabled or equipped technologies. The proposal portal can be found here: [Experiment Proposal - Field Experimentation - Naval Postgraduate School](#) Experiment proposals for JIFX 22-1 are accepted until September 22. Please continue to nominate experimenters and technologies to participate in JIFX.

Additional information on the exercise, reports, and quad charts are available [here](#).

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MISCELLANEOUS:

8. HYBRID FORCE 2045: A Vision of Future Aircraft Carrier Warfighting.

The Wayne P. Hughes Jr. Naval Warfare Studies Institute (NWSI) Seapower Conversations series features informal conversations with leading experts on the trends, technologies and tactics that shape modern seapower. On 5 August 2021, CAPT Robert C. "Barney" Rubel, USN (Ret.) shared his wealth of knowledge with more than 60 attendees on MS Teams and the NPS Watch Live website focused on HYBRID FORCE 2045: A Vision of Future Aircraft Carrier Warfighting. CAPT Rubel is a prolific writer regarding U.S. Naval Warfighting and is considered one of the

current experts in both future warfighting strategies and practice. In this Seapower Conversation CAPT Rubel examined the role Aircraft Carriers could have in future warfighting. CAPT Rubel's thesis is permeated with the writings of historical strategists, including the late CAPT Wayne P. Hughes. CAPT Rubel's presentation and discussion with attendees is available for download and viewing by clicking on the poster [here](#).

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9. Intermediate Force Capabilities (Non-Lethal Weapons)

On 18 August 2021, Colonel Wendell B. Leimbach (USMC) Director, Joint Intermediate Force Capabilities Office discussed the challenge our forces face at the threshold below armed conflict around the world with more than 50 attendees on MS Teams and the NPS Watch Live website. Colonel Leimbach is directly responsible for all Intermediate Force Capabilities (IFC) within the Department of Defense. This presentation focused on the relevance of IFC within the National

Defense Strategy and Service specific strategic doctrine. Colonel Leimbach discussed current and future potential technologies within this critical force capability area. Colonel Leimbach's full presentation and discussion with attendees is available for download and viewing by clicking on the poster [here](#).

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10. Scheduling Ship Maintenance Jobs in Multiple Ports to Minimize Workload Fluctuation

Surface ships in the Navy require planned and unplanned pier-side maintenance. These maintenance jobs, known as availabilities, are contracted out to private shipyards. Ship maintenance schedules must meet the Navy's operational requirements and stay within the capacity of the contracted shipyards. At the same time, it is important to minimize workload fluctuation in a port to help private shipyards train and maintain a skilled workforce. Building on recent work that schedules availabilities in a single port to minimize workload fluctuation, this thesis develops a port loading model to minimize workload fluctuation for all regional ports in the Area of Responsibility by allowing some ships to receive maintenance work out of their home ports. Scheduling availabilities across multiple ports simultaneously to level the workload in each port has

two additional benefits: First, an increase in the number of eligible companies who can bid on the maintenance job will drive down the cost for the Navy. Second, allowing more flexibility to assign availabilities to different ports has the potential to further level the workload at these ports. In a case study on three ports in the West Coast over a six-year period, we demonstrate the effectiveness of the multi-port loading model.

This publication is a work of the U.S. Government as defined in Title 17, United States Code, Section 101. Copyright protection is not available for this work in the United States. ENS Naldo's complete work is available [here](#).

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