U.S. Naval Postgraduate School: Historical and Contemporary Information Resources

Professor Bert Chapman

Government Information, History, and Political Science Librarian
Purdue University Libraries and School of Information Studies

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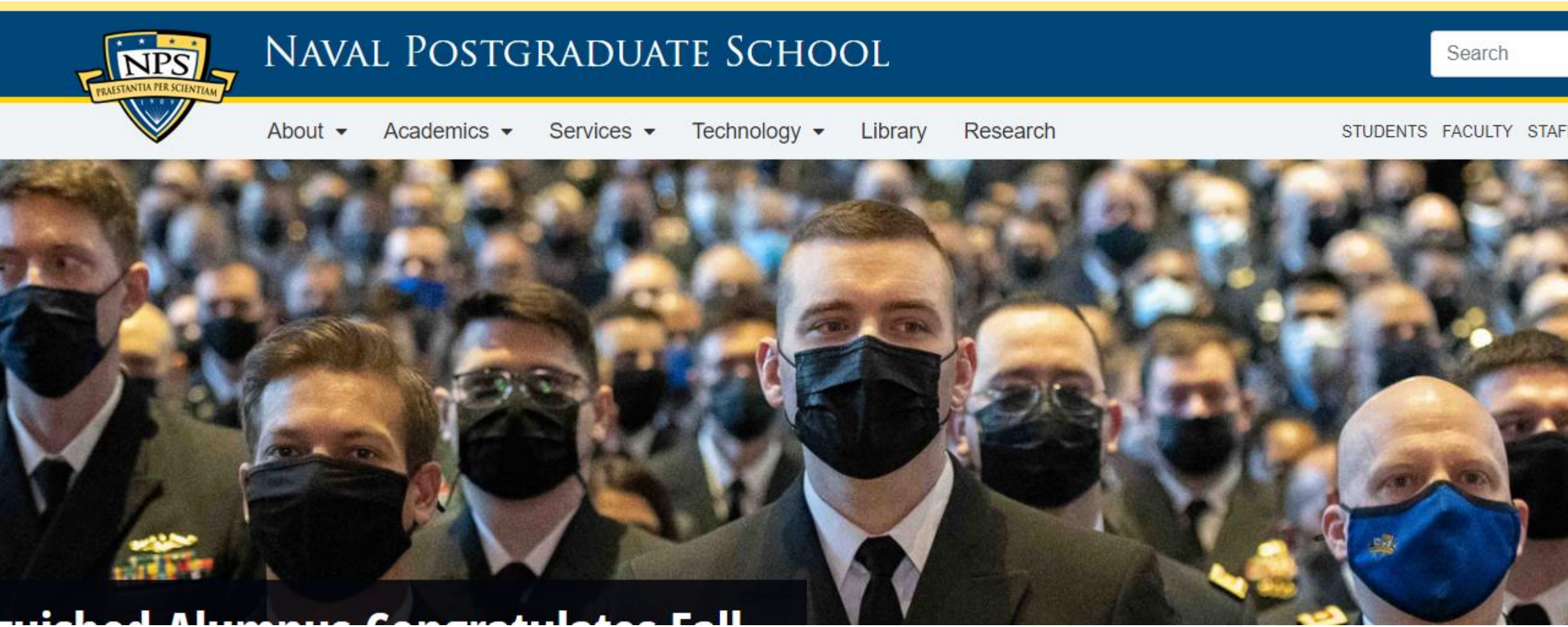
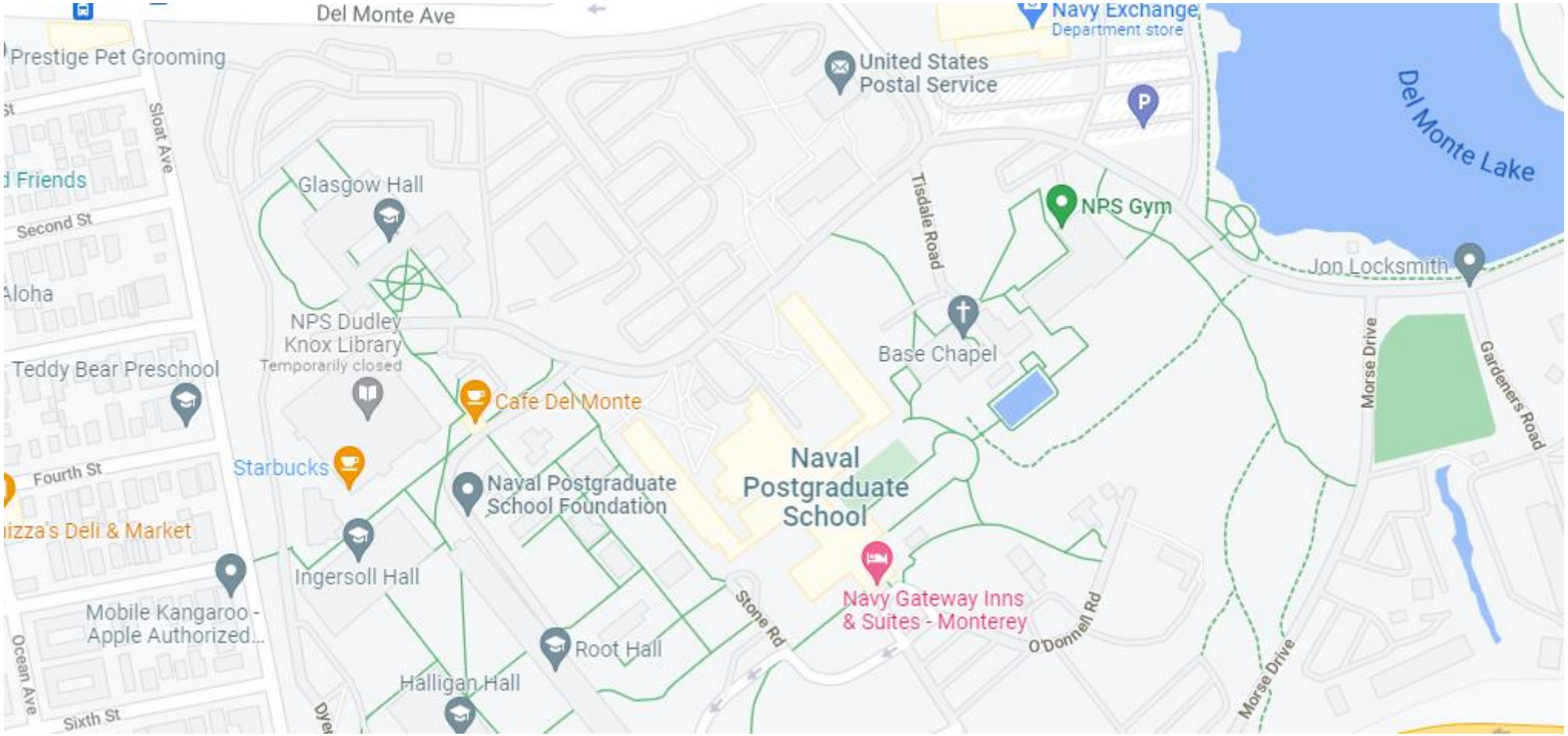
www.nps.edu/

NPS Motto “Praestanta Per Scientiam” means “Outstanding in Science”



Located in Monterey, CA



The Naval Postgraduate School provides defense-focused graduate education, including classifie studies and interdisciplinary research, to advance the operational effectiveness, technological leadership and warfighting advantage of the Naval service.

WHO WE ARE

We are who we serve

NPS is a Navy command and a defense graduate university. We are military leaders, defense-expert educators and staff serving those who serve our nation.

WHAT WE DO

Defense education & research

NPS develops warrior talent and research solutions through Master's and Ph.D. programs for the Department of the Navy, DoD, U.S. Government, partners and our allies.

WHY IT MATTERS

For decisive advantage

NPS ensures the technological leadership of th future force. Our graduates have the technical a intellectual edge to deter and prevail in the all-do battlespace.

NPS Mission Metrics

"Provides defense focused graduate education …"

68 graduate resident and distance learning programs in technical and engineering fields (2020 graduates: 305)

32 graduate resident and distance learning programs in defense management and security studies (2020 graduates: 203)

16,066 total student engagement (resident, distance, certificate, Exec-Ed)

82 continuous learning, certificate, short courses, special seminars, METs (2020 454 participants)

"… including classified and interdisciplinary research …"

More than **1,000** research thesis and capstone projects delivered every year

In 2020 over **150** interdisciplinary education, research, and field experimentation programs executed

In 2020 **30%** of all sponsored research was approached with interdisciplinary teams

In 2020 over **120** classified/restricted research and education activities were conducted (25% of all sponsored research)

In 2021 **60%** of NPS Naval Research programs directly support CNO Key Operational Problems

Initially Established October 9, 1909

- On this date Secretary of the Navy George von. L. Meyer signed General Order 27 establishing a School of Marine Engineering at Annapolis, MD.
- Navy General Order 223 on October 31, 1912 renamed the School the Postgraduate Department of the Naval Academy.
- Established additional courses in ordnance, gunnery, electrical engineering, radio telegraphy, naval construction, and civil engineering. Enrollment: 25
- 1945 Congress passes legislation (P.L. 79-250) this school a fully accredited degree granting graduate institution
- 1947-Congress authorizes purchase (P.L. 80-302) of Hotel del Monte and 627 acres of surrounding land In Monterey, CA for this institution.
- Dec. 1951-NPS moves to Monterey, CA with 500 students, 100 faculty and staff, and thousands of pounds of books and research equipment.
- 1950's Hotel del Monte and environs redesigned by architectural firm of Skidmore, Owings, & Merrill to be a modern technologically sophisticated campus.
- 1953 First automated digital computer purchased for Math Department

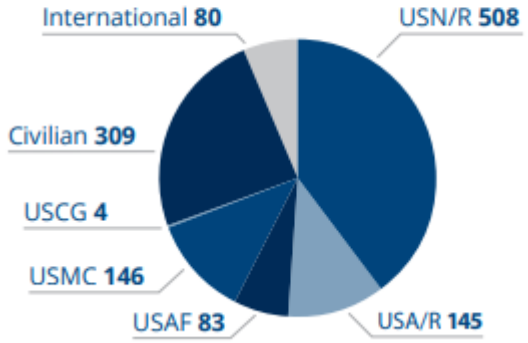
NPS History continued

- 1955 NPS receives provisional accreditation from Western Association of Schools & Colleges
- 1956 First female student officers arrive.
- 1959 Office of Naval Research established funded research program at NPS sponsoring first research projects.
- 1961 Mathematic student A. Martin Wildberg develops a semi-automatic bibliographic information retrieval system in Masters Thesis for Library patrons via punch cards, batch processing, & magnetic tapes.
- 1964 Dept. of Aeronautics opens Turbopropulsion Laboratory
- 1969 Computer Center dedicated
- 1971 NPS connects to Advanced Research Projects Agency (ARPANET). Mechanical Engineering Prof. Turgut Sarpkaya's research in fluid dynamics has major impact on U.S. submarine operations.
- 1972-Dudley Knox Library opens. Dept. of National Security Affairs adds international relations, regional politics and security, political economy, and U.S. security policy to NPS' sci-tech oriented curriculum.
- 1987 Center for Autonomous Underwater Vehicle Research established.
- 1988-BOSUN online catalog system established in Knox Library
- 1994-Center for Civil Military Relations established to educate foreign civilian and military personnel on current security subjects.
- 2002-Homeland Security Digital Library established

Current Statistics as of 2020.

- Student Enrollment/Engagement 16,606- 1,480 Resident Degree; 866 Distance Learning Degree; 425 Certificate Non-Degree; 13, 295 Executive Education/Professional Development
- Degrees Awarded 1,275; 1,259 Masters and 16 Doctorate

NPS Graduate Degrees Conferred by Service



Faculty & Staff

230 Tenure Track Faculty

Non-Tenure Track Faculty:

162 Instructional Faculty
178 Research Faculty
18 Administrative Faculty
328 Staff

Sponsored | Reimbursable

- Approx **$101 million** in sponsored/reimbursable funding expended
- Research programs are aligned to NPS curricula
- NPS research is valuable to improving the security of the U.S.

Financials

- **$105** million Direct Authorization: without military salary
- **$90** million Reimbursable Income

THE NPS STUDENT

NPS students are operationally experienced, mid-career officers, many with recent combat experience. At NPS we teach our students how to think critically and connect strategically. They become proficient at navigating uncertainty, comfortable with ambiguity and skilled at thinking about employing new techniques and technologies in situations they have not thought about before.

More than half of NPS students are officers of the U.S. Navy and Marine Corps, with significant representation from the other U.S. Armed Forces and DOD agency civilians studying side-by-side with international officers from 20-40 nations at any given time, as well as homeland security practitioners from across the nation.

These students are the world's military and civilian leaders of tomorrow, and have been selected to study in NPS' degree and certificate programs that prepare students for the next phase of their careers. Graduates apply their solutions and learning upon returning to the Fleet and operational forces.

Current Statistics 2020

Academic Facilities

62 Classrooms that offer media technology
8 Classrooms with Video-Conferencing
4 FLEX Classrooms of the Future
4 Auditoria
48 Labs

Accreditation

- WASC Senior College and University Commission (WSCUC)
- Accreditation Board for Engineering and Technology (ABET)
- Association to Advance Collegiate Schools of Business (AACSB)
- Network of Schools of Public Policy, Affairs, and Administration (NASPAA)

Source: Office of Institutional Research

INTERNATIONAL RESIDENT DEGREE STUDENTS

By Region – Average on Board 2020

Australia and New Zealand	
Australia	5.75
Total	**6**

North America	
Canada	3.75
Mexico	2
Total	**6**

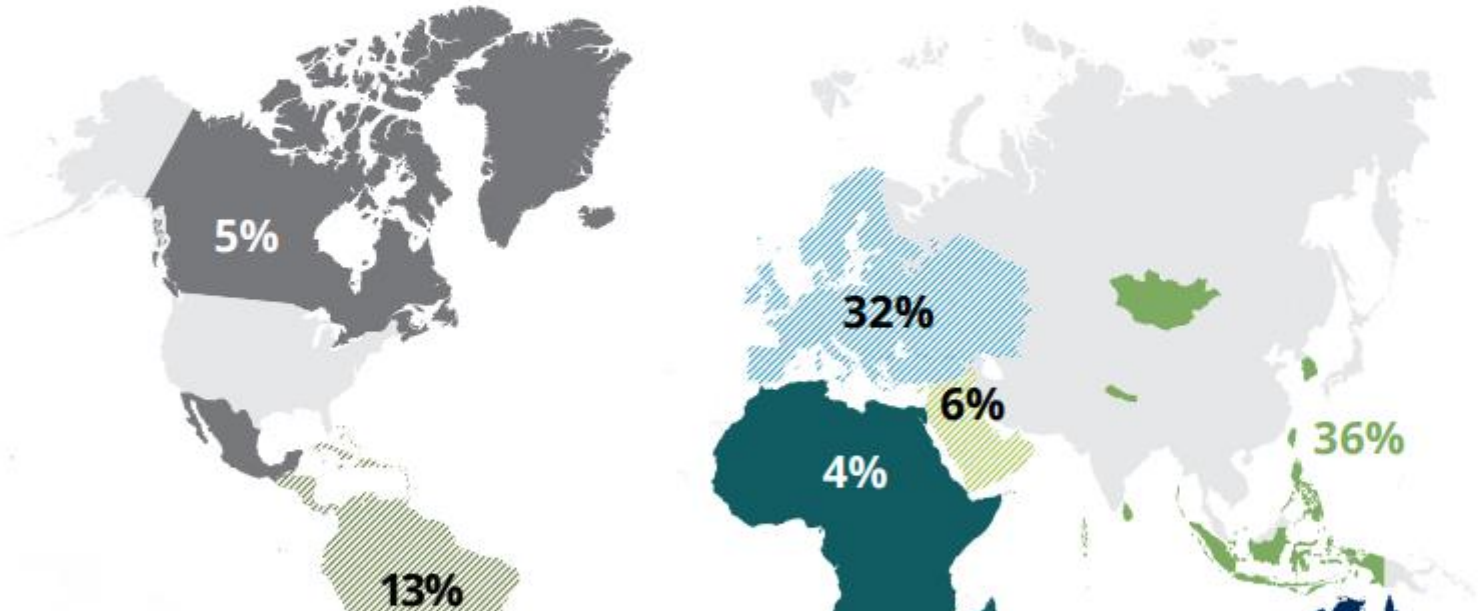
Central/East Asia and Middle East	
Bahrain	1
Iraq	0.5
Israel	1
Jordan	0.75
Lebanon	1
Saudi Arabia	3.75
Total	**8**

Africa	
Niger	1
Nigeria	1
Sierra Leone	1.75
Uganda	1.25
Total	**5**

Caribbean, Central and South America	
Brazil	10
Chile	1
Colombia	1.5
Costa Rica	0.5
Guyana	0.75
Peru	2
Total	**16**

Europe	
Armenia	0.75
Bulgaria	0.25
Denmark	0.75
Estonia	0.75
Finland	0.5
Georgia	3.5
Germany	9
Greece	10.25
Hungary	1.75
Lithuania	0.75
Netherlands	1.5
Norway	2
Portugal	1
Romania	1
Slovakia	0.75
Sweden	3.75
Switzerland	0.25
Turkey	0.5
Ukraine	1
Total	**40**

Far/Near East	
Indonesia	3.5
Korea	7.25
Maldives	1
Mongolia	1.25
Nepal	2.25
Philippines	6
Singapore	18.5
Sri Lanka	0.25
Taiwan	4.75
Thailand	0.25
Total	**45**



GRADUATE DEGREE ENROLLMENT

Average on Board 2020

Resident Programs		Curriculum Number	USN	USMC	Intl Military & Civilian	U.S. Civilian	Other Services	Grand Total
GSDM								
	Acquisitions & Contract Management	815	25	14	2	0	30	71
	Defense Systems Analysis	817	0	17	1	0	0	18
	Defense Systems Management (International)	818	0	0	2	0	0	2
	Financial Management	837	44	8	1	0	0	53
	Financial Management (Energy Specialty)	838	1	0	0	0	0	1
	Information Systems Management MBA	870	3	0	0	0	1	4
	Manpower Systems Analysis	847	25	17	4	0	1	47
	Materiel Logistics Support Management	827	9	9	1	0	0	19
	Resource Planning/Mgmt for Int'l Defense	820	0	0	2	0	0	2
	Supply Chain Management	819	13	0	1	0	0	14
	Systems Acquisition Management	816	2	0	0	0	4	6
	Transportation Management	814	0	<1	0	0	0	<1
GSDM Total			**121**	**65**	**13**	**0**	**36**	**235**
GSEAS								
	Aerospace Engineering	609	8	0	0	0	1	9
	Applied Mathematics	380	3	0	0	0	11	14
	Applied Mathematics (PhD)	381	1	0	0	1	1	3
	Combat Systems Science & Engineering	533	33	3	6	0	1	42
	Electronic Systems Engineering	590	45	16	10	2	0	72
	Electronic Systems Engineering (PhD)	594	6	0	0	0	0	6
	Engineering Acoustics (PhD)	536	0	0	1	0	0	1
	Meteorology	372	1	0	0	0	2	3

GRADUATE DEGREE ENROLLMENT continued

Resident Programs	Curriculum Number	USN	USMC	Intl Military & Civilian	U.S. Civilian	Other Services	Grand Total
GSOIS							
Applied Cyber Operations	336	6	3	0	0	0	9
Computer Science	368	33	23	7	18	1	82
Computer Science (PhD)	384	1	0	0	0	0	1
Cyber Systems and Operations	326	40	1	0	0	1	42
Human Systems Integration	362	0	0	1	0	1	2
Information Sciences (PhD)	474	0	2	1	2	1	6
Information Strategy and Political Warfare	698	0	0	0	1	16	17
Information Systems & Technology	370	0	26	0	0	0	26
Information Warfare	595	0	21	0	0	0	21
Joint Cmd, Cntrl, Comm, Comp/Intel (C4I) Sys	365	0	5	1	0	1	6
Modeling, Virtual Environments & Simulation	399	0	9	4	0	1	15
Modeling, Virtual Environments & Simulation (PhD)	398	1	1	0	0	1	3
Network Operations and Technology	386	30	0	0	0	1	31
Operations Analysis	360	44	27	10	0	15	95
Operations Analysis (PhD)	382	0	2	0	0	0	2
Operations Research Logistics Analysis	361	14	0	0	0	1	15
Special Operations	699	18	1	21	0	66	106
GSOIS Total		**186**	**120**	**45**	**21**	**107**	**478**
IDS							
Civil-Military Relations	685	0	0	3	0	0	3
Combating Terrorism: Policy and Strategy	693	0	0	14	1	0	15
Europe and Eurasia	684	10	8	2	1	14	33
Far East, Southeast Asia, Pacific	682	18	11	1	1	16	45
Homeland Defense and Security	692	0	0	0	120	4	124

FACULTY BY RANK

Tenure Track

RANK	GSDM	GSEAS	GSOIS	IDS	RESEARCH	ADMIN	TOTAL
PROFESSOR	15	44	29	8	1	3	100
ASSOCIATE PROFESSOR	18	28	21	13	--	1	81
ASSISTANT PROFESSOR	13	14	18	4	--	--	49
TOTAL	46	86	68	25	1	4	230

Non-Tenure Track

RANK	GSDM	GSEAS	GSOIS	IDS	RESEARCH	ADMIN	TOTAL
SENIOR LECTURER	15	13	20	9	--	3	60
LECTURER	16	10	10	10	--	11	57
PROFESSOR OF THE PRACTICE	6	10	2	--	1	--	19
RESEARCH PROFESSOR	--	7	3	--	--	--	10
RESEARCH ASSOCIATE PROFESSOR	1	12	10	1	--	--	24
RESEARCH ASSISTANT PROFESSOR	1	10	2	1	--	1	15
ADMINISTRATIVE FACULTY	1	2	4	4	--	7	18
ASSOCIATE FACULTY	8	58	70	9	1	6	152
VISITING FACULTY	2	--	1	--	--	--	3
TOTAL	50	122	122	34	2	28	358
GRAND TOTAL	96	208	190	59	3	32	588

Graduate School of Defense Management (GSDM)
Graduate School of Engineering and Applied Sciences (GSEAS)
Graduate School of Operational and Information Sciences (GSOIS)
School of International Graduate Studies (SIGS)

Patents

Systems, methods, and apparatuses for determining the distance between two positions

Romano, Marcello; Restaino, Sergio; Helmboldt, Joseph; (The United States of America, as represented by the Secretary of the Navy, Washington, DC (US) 2020-03-10).

Systems, methods, and apparatuses for determining the distance between two positions are disclosed. The system includes a correlator, a first receiver, and a second receiver. The first and second receivers each include: an antenna, a steering mechanism, and a processor. The steering mechanism steers the antenna in an azimuthal direction and an elevation direction. The processor is configured to (i) control the steering mechanism, (ii) receive data recorded by the antenna from a plurality of sources, (iii) time-stamp the data recorded by the antenna, and (iv) control the transmission of the time-stamped data to the correlator. The correlator is configured to receive the time-stamped recorded data from the first receiver and the second receiver, and calculate a distance between the first receiver and the second receiver based thereon.

Methane/oxygen rocket engine with specific impulse enhancement by hot helium infusion

Biblarz, Oscar; Hobson, Garth V.; (The United States of America, as represented by the Secretary of the Navy, Washington, DC (US) 2020-03-31).

An apparatus and method to enhance the performance of rockets engines which utilize liquid methane/oxygen pro¬pellants by injecting optimized amounts of pressurized hot helium gas into the combustion chamber with the propel¬lants. In one embodiment, the pressurized helium gas is stored at low temperatures near those of the cryogenic propellants and is used for regenerative cooling of the combustion chamber and nozzle during rocket operation in order to raise the temperature of the helium gas before being injected into the combustion chamber.

Systems and methods for low temperature metal printing

Phillips, Jonathan; (The United States of America, as represented by the Secretary of the Navy, Washington, DC (US) 2020-05-12).

Unconventional warfare wargame

Arias, Jeremy; Klay, Chad; (The United States of America, as represented by the Secretary of the Navy, Washington, DC (US) 2020-04-07).

A board game for simulating unconventional warfare. The board game of the present invention includes hexagonal territory board pieces, resource production unit markers, and infrastructure markers for representing territory, resource production units, and infrastructure in an unconventional warfare scenario. The infrastructure markers include (1) base markers that can be placed at intersections of the hexagonal pieces, where each base marker allows a player to collect double resources and build military units; (2) population influence markers that can be placed at the intersections, where each population marker allows the player to collect resources and conduct influence attacks on neighboring infrastructure; and (3) military unit markers that can be placed at the intersections, where each military unit markers allows the player to conduct military attacks on the neighboring infrastructure.

Description	2014	2015	2016	2017	2018	2019	2020
LIVE ONLINE EVENTS							
Live Streaming Events (Total Events)							20
Live Streaming Events (Total Hours)							26
Live Streaming Events (Total Attendance)							4,787
Zoom Webinars Total Events [7]							15
Zoom Webinars Total (Hours) [7]							20
Zoom Webinars Total Atendance [7]							1,156
Teams Live Events Total Events							4
Teams Live Events Total (Hours)							6
Teams Live Events Total Attendance							N/A[3]
ZOOM/TEAMS SUPPORT							
Zoom/Teams Enabled Classrooms							8
Zoom/Teams Enabled Meeting Rooms							1
Zoom Meeting Sessions (Total) [7]							42,635
Zoom Meeting (Hours) [7]							425,921
Zoom Meeting Participants (Total) [7]							387,980
Zoom Cloud Recordings (Total) [7]							1.17 TB
Logins to the learning management system (not distinct users)	1,048,039	1,692,040	1,013,306	1,037,324	1,111,503	1,131,434	1,430,125
Sites (Courses and Projects) hosted on the learning management system	7,821	9,308	10,787	11,956	13,536	14,648	16,871

Research Thrusts

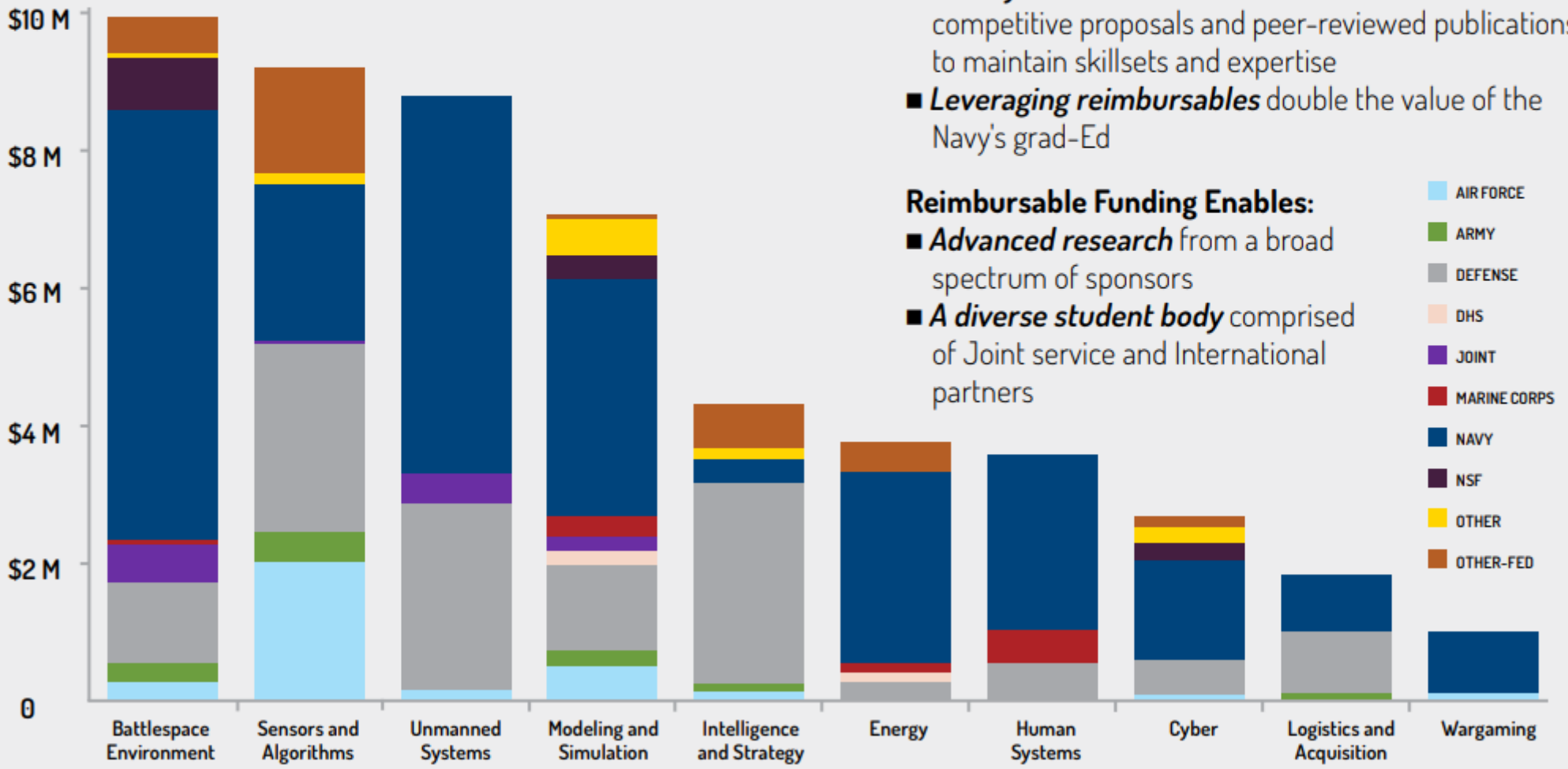
Research at NPS is intently focused on critical issues within the Depart-ments of the Navy and Defense. Annually, the top 10 focal areas of NPS research are directly aligned to key operational problems detailed by Naval leadership in fleet and force strategies.

Research & Sponsored Programs Support:

- ***Operational relevance*** through resource sponsors
- ***Educational quality*** through thesis and capstone projects
- ***Faculty Recruitment, Retention & Relevance*** with competitive proposals and peer-reviewed publications to maintain skillsets and expertise
- ***Leveraging reimbursables*** double the value of the Navy's grad-Ed

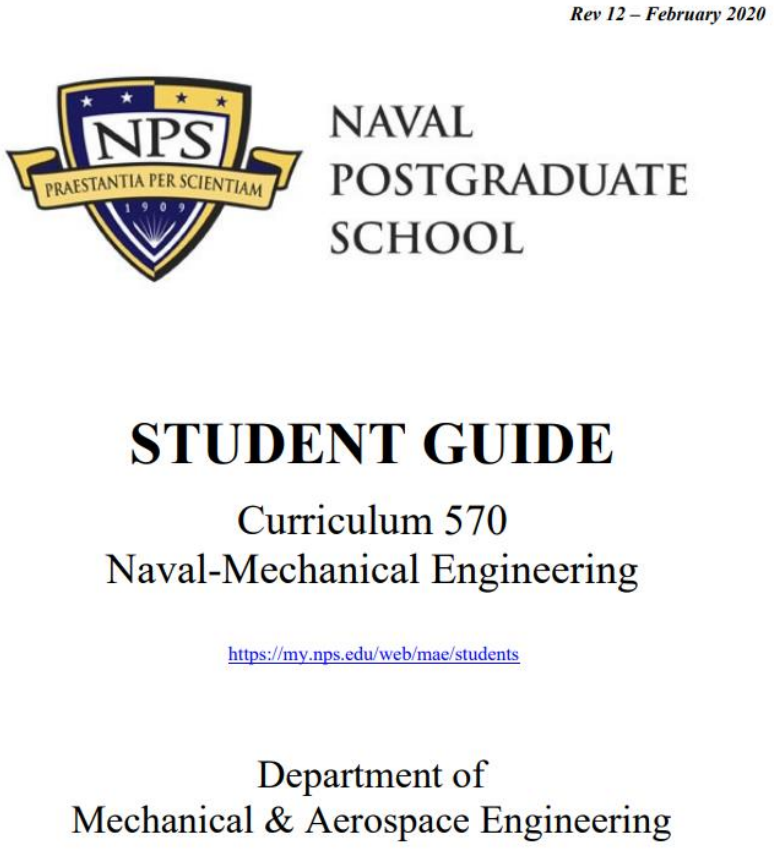
Reimbursable Funding Enables:

- ***Advanced research*** from a broad spectrum of sponsors
- ***A diverse student body*** comprised of Joint service and International partners



NPS Instruction-Schools & Departments

- Graduate School of Engineering & Applied Science-Programs:
  Applied Mathematics, Electrical & Computing Engineering, Engineering Acoustics, Physics, Systems Engineering, Mechanical & Aerospace Engineering, Meteorology, Oceanography
- Graduate School of International & Defense Studies-Depts. Of National Security Affairs-Masters and Ph.D. degrees; Center for Homeland Security & Defense
- Graduate School of Operational and Information Sciences-Programs: Computer Science, Defense Analysis, Information Sciences, Operations Research, Cyber Academic Group, Data Science & Analytics Group



Rev 12 – February 2020

NPS
PRAESTANTIA PER SCIENTIAM
1909

NAVAL
POSTGRADUATE
SCHOOL

STUDENT GUIDE

Curriculum 570
Naval-Mechanical Engineering

https://my.nps.edu/web/mae/students

Department of
Mechanical & Aerospace Engineering

This Naval Mechanical Engineering Student Guide is 34 pages!

Excerpt from 2012 NPS student research guide

An afternoon in the library can save you a month in the laboratory…
(author unknown)

- There is an *INCREDIBLE* amount of technical information already out there…examples just from Web of Science database
  - 23,000 journals
  - 23 million patents from 40 patent-issuing authorities
  - 110,000 conference proceedings
  - 700 million cited references
- Not spending time in the library can result in
  - Reinventing the wheel
  - Designing experiments or simulations that will not work
  - Not being able to compare your data with other recognized studies
- You want to <u>build</u> on what others have already done

Courses

- Office of Academic Administration-Academic Catalog Content
- USW (525) Curriculum Fall Matrix
- USW (525) Curriculum Spring Matrix

Students in the Undersea Warfare Program earn a Master of Science degree in one of several degree programs in the Graduate School of Engineering and Applied Sciences or Graduate School of Operations and Information Sciences as they pursue research in the undersea domain.

Such degrees include:

Engineering Acoustics

Applied Math

Applied Physics

Physical Oceanography

Operations Research

Mechanical Engineering

Electrical Engineering

In addition, US Navy students earn a 6301P subspecialty code and Phase 1 JPME certification.

Undersea Warfare – Core Matrix – Spring Start – Updated June 2011

Refresher	**MA1113** **Single Variable Calc** **(4-0)**	**MA1114** **Single Variable Calc and Matrix Algebra** **(4-0)**	**OC3230** **Descriptive Physical Oceanography** **(3-1) (Su,W)**	**NW3285** **Nat'l Security Decision Making** **(4-0)**	**UW0001** **Seminar** **(0-1)**	
1-Sp	**MA1115** **Multi-Variable Calc** **(4-0)**	**MA1116** **Vector Analysis** **(4-0)**	**MA2121** **ODE's** **(4-0)**	**PH3401** **Sonar Equations** **(3-0) (Sp,F)**	**UW0001** **Seminar** **(0-1)**	**OC2020** **Matlab** **(2-2)**
2-Su	**Degree Requirement**	**MA3139** **Fourier Anal &PDEs** **(4-0)**	**OC3230** **Descriptive Physical Oceanography** **(3-1) (Su,W)**	**Degree Requirement**	**UW0001** **Seminar** **(0-1)**	
3-F	**NW3285** **Nat'l Security Decision Making** **(4-0)**	**PH3002** **Non-Acoustic Sensors** **(4-0) (F)**	**OC3260** **Sound in the Ocean** **(4-1) (Sp,F)**	**Degree Requirement**	**UW0001** **Seminar** **(0-1)**	
4-W	**Degree Requirement**	**NW3230** **Strategy and Policy** **(4-2)**	**OC4270** **Tactical Oceanography** **(3-4) (Su,W)**	**OS2103** **Applied Probability** **(4-1) (W)**	**UW0001** **Seminar** **(0-1)**	
5-Sp	**Degree Requirement**	**NW3275** **Joint Maritime Operations I** **(4-0)**	**ME3720** **Intro to Unmanned Systems** **(3-2) (Sp)**	**OS3604** **Statistics and Data Analysis** **(4-1) (Sp)**	**UW0001** **Seminar** **(0-1)**	
6-Su	**E02402** **Intro to Linear Sys** **(4-1) (Su)**	**NW3276** **Joint Maritime Operations II** **(4-0)**	**XX0810** **Thesis Research** **(0-8)**	**OA3602** **Search Theory and Detection** **(4-0) (Su,W)**	**UW0001** **Seminar** **(0-1)**	**UW2001** **History of USW** **(2-0) (Su)**
7-F	**EO3402** **Signals and Noise** **(3-1) (F)**	**Degree Requirement**	**XX0810** **Thesis Research** **(0-8)**	**OA4607** **Tactical Decision Making** **(4-0) (F)**	**UW0001** **Seminar** **(0-1)**	**UW2002** **History of USW** **(2-0) (F)**
8-W	**EC4450** **Sonar System Engineering** **(4-1) (W)**	**XX0810** **Thesis Research** **(0-8)**	**XX0810** **Thesis Research** **(0-8)**	**XX0810** **Thesis Research** **(0-8)**	**UW0001** **Seminar** **(0-1)**	

Degree Approval Plan should be submitted as soon as possible but not later than end of 2nd quarter

Graduate School of International & Defense Studies Curricula

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree/ Certificate	Program Officer
Maritime Security Cooperation Certificate	241	3 months	Fall/Spring	N/A	None	NS	Certificate	Christian Richer
RS Studies (Middle East, South Asia, and Sub-Saharan Africa) Certificate	246	3-9 months	Any Quarter	N/A	2101L	NS	Certificate	Christian Richer
RS Studies (East Asia and the Indo-Pacific) Certificate	247	3-9 months	Any Quarter	N/A	2102L	NS	Certificate	Christian Richer
RS Studies (Western Hemisphere) Certificate	248	3-9 months	Any Quarter	N/A	2103L	NS	Certificate	Christian Richer
RS Studies (Europe and Eurasia) Certificate	249	3-9 months	Any Quarter	N/A	2104L	NS	Certificate	Christian Richer

GSOIS offers curricula and degree programs to resident and non-resident degree students.

Computer Science (CS) Curricula

Computer Science catalog home

Master of Science in Computer Science (Curriculum 368)

- Thesis Resources and Policy
- CS Course Matrix (PDF)
- CS Advanced Course Offerings Projection

Doctorate in Computer Science (Curriculum 384)

- PhD Handbook
- General information

Software Engineering Program (Curriculum 369)

- General information

Modeling of Virtual Environments and Simulations

Defense Analysis (DA) Curricula

The Department of Defense Analysis is home to two very unique and highly respected graduate programs: 1) the USSOCOM-sponsored Special Operations and Irregular Warfare (SO/IW) program, and 2) the USDP-sponsored Information Strategy and Political Warfare curriculum. Both programs feature an interdisciplinary faculty representing a wide range of academic and operational specialties.

Masters of Science in Applied Design for Innovation (697)

Academic Associates:

Leo Blanken, Ph.D.

CDR Justin Davis

The objective of this curriculum is to educate military personnel and civilian officials of the United States and its Allies to better defend the nation and

Coursework

Most of the courses in our curricula cover topics similar to courses in civilian O.R. programs, such as computational methods, statistics and data analysis, stochastic models, linear and non-linear optimization, network flows, simulation, and decision analysis. But in our program, all of these are enriched with examples that relate to student experiences and faculty research. We also study and teach military-relevant topics that are not commonly found in other programs, including combat modeling, campaign analysis, wargaming, cost analysis, and search theory. These topics are critical to our sponsors and are in keeping with the foundational roots of operations research. These courses help directly prepare our graduates to be military practitioners of OR.

Most resident students complete a curriculum that consists of one quarter of “refresher” courses, plus seven quarters of instruction. Navy students

CS matrix, 24 month + 3 month refresher schedule template

Q0 Su/Wi	CS2001 (3-3) Fundamentals of Computing Systems	CS2020 (3-4) Intro to Programming	MA2025 (4-1) Logic and Discrete Mathematics	NW3230 (4-2) Strategy and War	
Q1 Fa/Sp	CS2011 (4-0) Computing Systems Principles	CS3040 (4-2) Low-level Prog I	CS3001 (4-2) Formal Foundation of CS	OS3307 (4-1) Modeling Practices for Computing	CS4924 (1-0) Seminar Series in CS and CSO
Q2 Su/Wi	CS3200 (3-2) Computer Architecture	CS3021 (4-2) Intro to Data Structures & Intermediate Prog	CS3502 (4-2) Computer Comm. and Networks	CS3070 (3-2) Operating Systems	CS4924 (1-0) Seminar Series in CS and CSO
Q3 Fa/Sp	CS3600 (4-2) Intro to Computer Security	CS3140 (3-2) Low-level Prog II	CS3101 (4-2) Theory of Formal Languages & Automata	CS3310 (4-1) Artificial Intelligence	CS4900 (2-0) Technology & Transformation
Q4 Su/Wi	CS3250 (3-3) Intro to Cyber Physical Systems	CS3150 (4-0) Design and Analysis of Algorithms	CS3060 (3-1) Database Systems	SW3460 (4-2) Software Methodology	CS4903 (2-0) Research Methods in CS
Q5 Fa/Sp	CS0810 (0-8) Thesis Research	Breadth Elective	CS3315 (3-1) Intro to Machine Learning & Big Data	CS3004 (3-2) Human-Computer Interaction	CS4924 (1-0) Seminar Series in CS and CSO
Q6 Su/Wi	CS0810 (0-8) Thesis Research	Specialization Requirement	Specialization Requirement	NW3275 (4-0) JMO Part 1	CS4924 (1-0) Seminar Series in CS and CSO
Q7 Fa/Sp	CS0810 (0-8) Thesis Research	Specialization Requirement	Specialization Requirement	NW3276 (2-2) JMO Part 2	CS4924 (1-0) Seminar Series in CS and CSO
Q8 Su/Wi	CS0810 (0-8) Thesis Research	Specialization Requirement	Specialization Requirement	NW3285 (4-0) TSDM or MN3331 USMC	CS4924 (1-0) Seminar Series in CS and CSO

Research slots Specialization Refresher JPME Seminar series Core

NPS Research Centers-Multiple historical and current centers representing multiple subject areas

The Cebrowski Institute for Military Innovation

What we are seeing, in moving from the industrial age to the information age, is what amounts to a new theory of war. We have come to call that new theory of war network-centric warefare. Its not about the network; rather, its about how wars are fought and how power is developed. -- Vice Admiral Arthur K. Cebrowski (U.S. Navy, Ret.)

Mission

The Cebrowski Institute for Military Innovation incubates innovations for conducting military affairs in the age of digital technologies. The Institute defines innovation as the adoption of new practice in a community. Faculty who affiliate with the Institute have sensed emerging areas that may be of interest to the Navy and DoD, including technologies, practices or cultural phenomena. The metaphor of surfing is used to to describe sensing as deciding which innovation waves to catch and ride. A garden metaphor describes the Institute's work to incubate growth. When ready, projects are transitioned to others at NPS, the Navy or DoD. Read more...

Drones on Deck

Vice Admiral Arthur K. Cebrowski (U.S. Navy, Ret.) discusses the following topics:

- Naval Postgraduate School "Conversations

Mission

We incubate innovations for conducting military affairs in the age of digital technologies

JULY 2, 2003 | PART OF OPEN PHONES

Report Video Issue

Washington Journal

U.S. Military Force Transformation

Vice Admiral Cebrowski talked about proposed plans for transformation of the U.S. military, the need for military reform, and the process of reform. He also responded to viewer comments and questions.

Cebrowski's Current Incubations

The Cebrowski Institute focuses incubations based on surfing for emergences, interdisciplinary networks, serendipity, design, and innovation.

Big Ideas

Peter Denning (CS) and John Arquilla (DA)

The Big Ideas Exchange (BIX) is an NPS initiative that brings forward new and potentially game-changing thinking developed by NPS faculty and students to address grand challenges in American national security. These fresh approaches can become the lifeblood of future innovations in military and naval organization, doctrine, and strategy. They augur larger changes emerging in the world from recent technological advances.

- Helping Navy leadership think and position for what is coming
- Surfing emerging waves of technologies and possibilities, in search of new ideas that may change the world and military operations
- Avoiding technology surprises
- Setting future education requirements
- Positioning for emerging technologies

Adopted projects that have emerged from within the Cebrowski Institute

Ultimately, we end up having to focus at the tactical level because that's where transactions take place. The tactical level is the check-out counter in the great department store of national security. -- Vice Admiral Arthur K. Cebrowski (U.S. Navy, Ret.)

Cebrowski Institute Highlights:

Big Ideas | Climate Change | Crowd Sourcing | Cyber Adventurers | Design Thinking | Energy | Global Public Policy | HFN | Information Dominance | Innovation Adaption | JIEDDO | Military Wireless Communications | Mobile Wireless Communications | Mobile Devices | Natural Language Processing | Navy Tactical Cloud | Next Generation Leaders | STEM | Technology Transfer | TIDES | VIRT | W2COG

Climate Change

- Navy Artic Roadmap
- Adaption and Resilience
- Climate and Security

Mission

The Naval Warfare Studies Institute (NWSI) coordinates the Naval Postgraduate School's interdisciplinary research and education to accelerate and enhance warfare concept and capability development of tactically and technically informed solutions for the U.S. Navy and Marines Corps.

Upcoming Events

- **NWSI Strategic Deterrence Exploration Workshop** - ***10/11 & 18 February 2022.*** Recruting NPS students for exploration teams. Email nwsi@nps.edu with interest!
- **NWSI Nimitz Group Warfare Innovation Workshop *21-24 March 2022*** - *more details soon*

Visit the Warfare Innovation Worskhop page for more information about workshops past, present, and future.

The next NWSI Seapower Conversation is in February 2022 - more details soon
Click the Seapower Conversations drop down menu below for more information on previous

Assumptionitis in Strategy

Augier, Mie; Barrett, Sean F.X.; Mullen, William F. III

thestrategybridge

Assumptions are key to getting strategy right, but they are oftentimes flawed, unrealistic, and difficult to change because strategists tend to view the world based on what is familiar to them. Former Secretary of Defense Robert S. McNamara described this phenomenon: "We see what we want to believe."[5] Entrenched beliefs prevent cognitive agility and seeing the need for conceptualizing the world in different ways. This is particularly damaging in a world that is changing quickly and in often unpredictable ways. The increasing and overwhelming amount of information available only compounds this problem. As Nobel Laureate Herbert Simon noted, "[A] wealth of information creates a poverty of attention," which makes critical and strategic thinking even more important.[6]

Academic disciplines and textbooks can exacerbate the tendency for making erroneous assumptions by approaching decision making, including strategic decision making, from the point of view of just one or two disciplines rather than starting with the empirical behavior of humans. Kahn and Mann warn, "[M]any analysts do become enamored of intellectual and mechanical gadgets . . . They are easily seduced into emphasizing the use of such tools rather than focusing attention on the real problems."[7] This tendency manifests itself especially in the mistaken assumption of unbounded human rationality.[8] Noticing the need for a more realistic conception of humans, Simon, a pioneer

OVERCOMING ASSUMPTIONITIS WITH EMPIRICALLY GROUNDED, INTERDISCIPLINARY THINKING

There is no easy fix for assumptionitis. However, there are some approaches and ideas that can help mitigate making assumptions that lead us to misguided policy that is difficult, if not impossible, to implement–or worse, lead us in unproductive, perhaps even dangerous, directions. In particular, we suggest the following can improve our understanding and practice of strategy:

- Interdisciplinary and problem-driven approaches focus on the problem, not on the technologies, theories, models, or textbook analyses we prefer. The U.S. Air Force, for example, uses the "Kessel Run" approach in which they assemble a team of recognized experts in various disciplines to dive deeply on a challenge to identify and truly understand its nature before determining what they should try to do about it. This approach can be employed at the strategic level as well, but the people involved should not be the daily decision-makers. Expecting already busy people to perform this type of analysis is unrealistic. Furthermore, expecting this type of analysis to be done quickly–e.g., within a given news cycle–would further complicate and likely undermine the effort. Patience is key to getting it right. Organizationally, General David H. Berger's desire to establish a strategic thinking capability for the U.S. Marine Corps is another potentially useful step in this direction that

2021-07

Educating for Seapower: Developing intellectual agility through active learning

Augier, Mie; Barrett, Sean F.X.

Marine Corps Association

Educating for Seapower

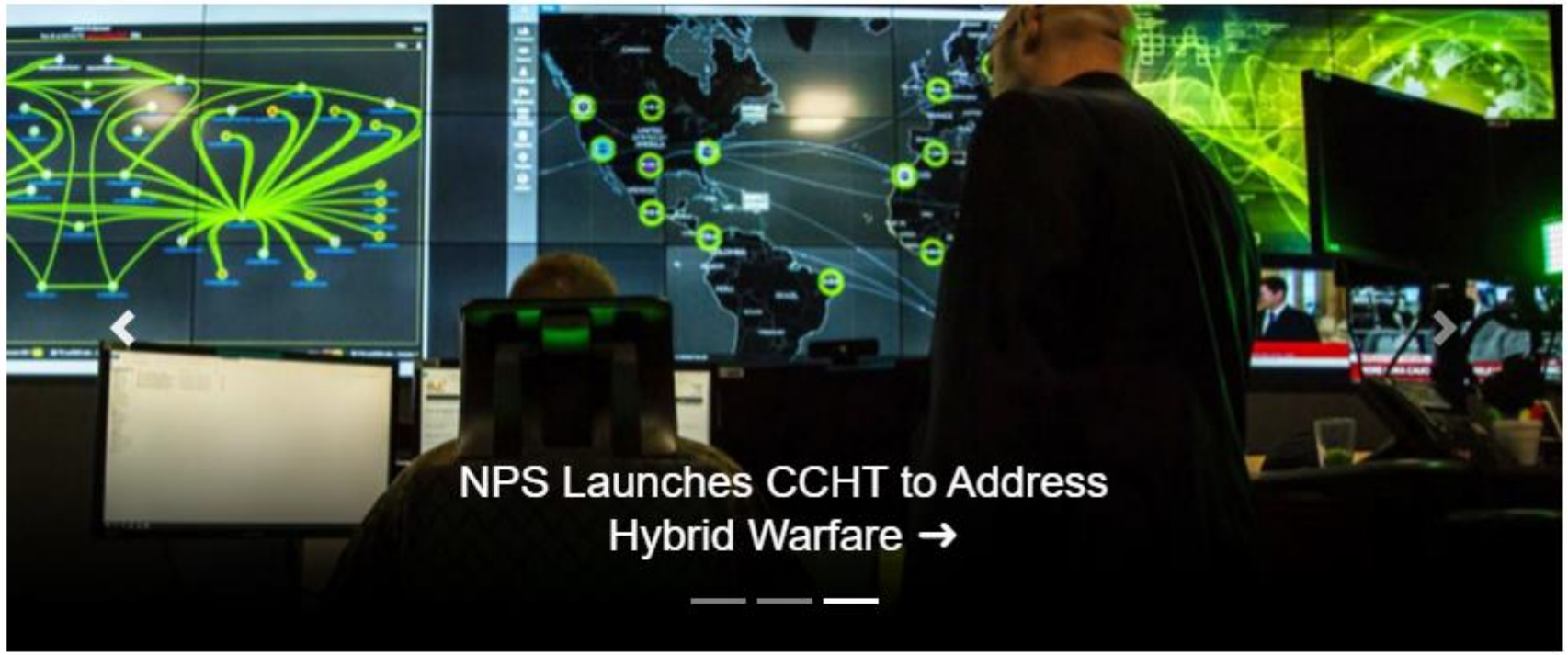
Developing intellectual agility through active learning

by Dr. Mie Augier & Maj Sean F.X. Barrett

A major goal of teaching problem solving and critical thinking should be preparing the student for lifelong learning by inculcating the skills of self-instruction.

Center on Combating Hybrid Threats

Center on Combating Hybrid Threats



The Center on Combating Hybrid Threats (CCHT) coordinates and conducts interdisciplinary research, education programs, and outreach in order to enhance the Naval Postgraduate School students and partners with the strategic, operational, and technological means necessary to detect, deny, disrupt, degrade, defeat and ultimately deter hybrid threats.

The purpose of the center is to focus on both anti-hybrid threats measures and countering hybrid operations through the collaborative approach outlined in our vision.

Education

Graduate level education related to hybrid threats for resident, non-resident, and distance learning students. Learn more

Research

Innovative and interdisciplinary research by NPS faculty and students on topics related to hybrid threats. Learn more

> “Hybrid threats combine military and non-military as well as covert and overt means, including disinformation, cyber attacks, economic pressure, deployment of irregular armed groups and use of regular forces. Hybrid methods are used to blur the lines between war and peace, and attempt to sow doubt in the minds of target populations.”
>
> NATO'S RESPONSE TO HYBRID THREATS

Research Projects

Faculty will conduct research, and support student research, on topics related to hybrid threats and leverage the interdisciplinary expertise of Center members and partners.

Potential Research Topics:

- Innovation and Combating Hybrid Threats
- The Common Operational Picture in the Multi-Domain Hybrid Threat Environment
- Indications and Warnings to Detect Hybrid Attacks
- Challenges of Attribution
- Identifying Adversary Vulnerabilities to Hybrid Campaigns
- Assessing Emerging Technology as Both Threats and Tools
- Public-Private and Civil-Military Cooperation in a Hybrid Threat Environment
- Strategic Framework to Defeat Hybrid Threats
- Maritime Security in an Age of Hybrid Threats
- Naval Forces Resilience Against Hybrid Threats
- Hybrid Warfare and Interoperability
- Military Strategic Communications
- Cyber Defense
- The Role of Energy Security in Hybrid Warfare
- Critical Energy Infrastructure Protection
- Improving Individual Resiliency
- Combating Disinformation
- Deterrence and Hybrid Threats
- Adversary Hybrid Strategies, Operations, and Tactics

Sponsor Proposed Thesis Topics:

- Combating Malign Behavior at Sea
- Kinetic and Non-kinetic Hybrid Threats on Critical Infrastructure
- Anticipated Non-kinetic Threats in Cyber Domain
- Application of Narrative Economics to Escalation and De-escalation of Irregular Warfare
- Use of Discrete Addictive Manufacturing to Help Mosaic Hybrid Warfare
- AI and Machine Learning in Manipulating Adversarial Posture in Combating Hybrid Threats
- Disinformation in Hybrid Warfare

Comprehensive Security Approach in Response to Russian Hybrid Warfare

Lt Col Tuukka Elonheimo, Finnish Air Force

Abstract

This article assesses why open, digitalized Western democracies are prone to hybrid warfare and analyzes versatile overt and covert mixed warfare methods in the modern information-dependent and interconnected environment. It also draws on various hybrid warfare influence methods and explains the broader concept and essence of Russian hybrid warfare. Besides analyzing structural hybrid warfare challenges, the article assesses and proposes means and practices to mitigate, act against, and deter overt or covert hybrid offensives. The article argues that Russian mixed warfare methods in tandem create a potential threat to Western democracies' unity and decision-making. However, these Western states could mitigate and prevent the implications of hybrid warfare by increasing comprehensive security, cooperation, situational awareness, preparedness, and resilience. The article identifies that the combined use of proper coordination, cooperation, information sharing, education, and readiness among authorities, governmental and nongovernmental organizations, businesses, and citizens could diminish these multifaceted, ambiguous hybrid aggressions.

*****

Source: Defense One Nov. 3, 2021

Migrants stand behind a fence inside the newly built refugee camp in the Rudninkai military training ground, some 38km (23,6 miles) south from Vilnius, Lithuania, Aug. 4, 2021. AP / MINDAUGAS KULBIS

IDEAS

Belarus's Weaponized Migrants Offer a Primer on Gray-Zone Warfare

Western governments would do well to study Minsk's actions—and prepare their populations to be on guard.

First Belarus arranged for a few hundred migrants to cross the border into Lithuania. Then the number grew to several thousand. Then Belarus brought more migrants to Minsk and pushed them into Latvia and Poland; thousands have since made their way to Germany. All this is likely just the start: Belarusian President Alexander Lukashenko is sharply increasing the number of airline flights from Middle Eastern cities to Minsk.

Climate and Security at NPS

"No nation can find lasting security without addressing the climate crisis."

– SECRETARY OF DEFENSE LLOYD J. AUSTIN, APRIL 2021

DOD is taking action to address the security implications of climate change, both due to its effect on military infrastructure, readiness and operations, and its broader geostrategic implications for the US.

NPS is answering DoD's need for research and analysis on climate and security topics from oceanography and meteorology to energy and security affairs.

The NPS **Climate and Security Network** brings these experts together to answer research needs from DOD and offer NPS students a more thorough understanding and set of skills related to these issues.

The Perfect Storm: Climate-Induced Migration to the United States

From the Mariel boatlift in the 1980s to the 2019 Southern Border Crisis, the United States has consistently been unprepared to handle mass migration events. With the world approximately 1.0°C warmer than pre-industrial levels, climatic-driven migration events will increasingly challenge the U.S. borders. This thesis explores how the United States might prepare to handle cross-border climate change-induced migration from a homeland security perspective. Using the research methodology of scenario planning, this study assesses the many ways the future might unfold by focusing on intersecting global megatrends and an array of global warming projections in the year 2050. This thesis finds that regardless of how the world chooses to combat global warming, migration will continue. Thus, to prepare for such a future, regional agreements and national legislation will be necessary. In turn, if leveraged correctly, climate migrants could help the United States compete with future emerging economies. Ultimately concluding that a proactive approach to climate-induced migration might not only benefit climate migrants but also the future resiliency of the United States well into the mid-century.

Contact: Katelin Wright | Email

Co-Advisors: Rodrigo Nieto-Gomez, Department of National Security Affairs &Christopher Bellavita (contractor)

http://hdl.handle.net/10945/66051

2020-09

THE PERFECT STORM: CLIMATE-INDUCED MIGRATION TO THE UNITED STATES

Wright, Katelin M.

Monterey, CA: Naval Postgraduate School

THE PERFECT STORM: CLIMATE-INDUCED MIGRATION TO THE UNITED STATES

Katelin M. Wright
Senior Immigration Services Officer III,
U.S. Citizenship & Immigration Services, Department of Homeland Security
BA, University of Nebraska at Lincoln, 2011

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF ARTS IN SECURITY STUDIES
(HOMELAND SECURITY AND DEFENSE)

from the

NAVAL POSTGRADUATE SCHOOL
September 2020

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Selected Recommendations

1. DHS should incorporate climate change into all six homeland security missions and update the *DHS Strategic Plan* accordingly. The effects of climate change will impact DHS in its entirety, not only the U.S. immigration system. Instead of reinventing the wheel, DHS should re-assess the prior recommendations and actions laid out in the former *DHS Climate Action Plan* and reinstitute best practices as appropriate.
2. In terms of immigration, DHS and its immigration sub-branches should re-assess the impacts climate change will have on mass migrations from the Caribbean, Central America, and South America.
3. The Department of State should expand the scope of the Caribbean Basin Security Initiative to include climate-induced migration and its related security implications.
4. The United States should pursue a regional free-movement agreement with the Caribbean Islands focused on climate-induced migration. In addition, Congress should consider creating a Caribbean-specific temporary visa program focused on critical job shortages, using Australia's Pacific Labour Scheme as a replicable framework.

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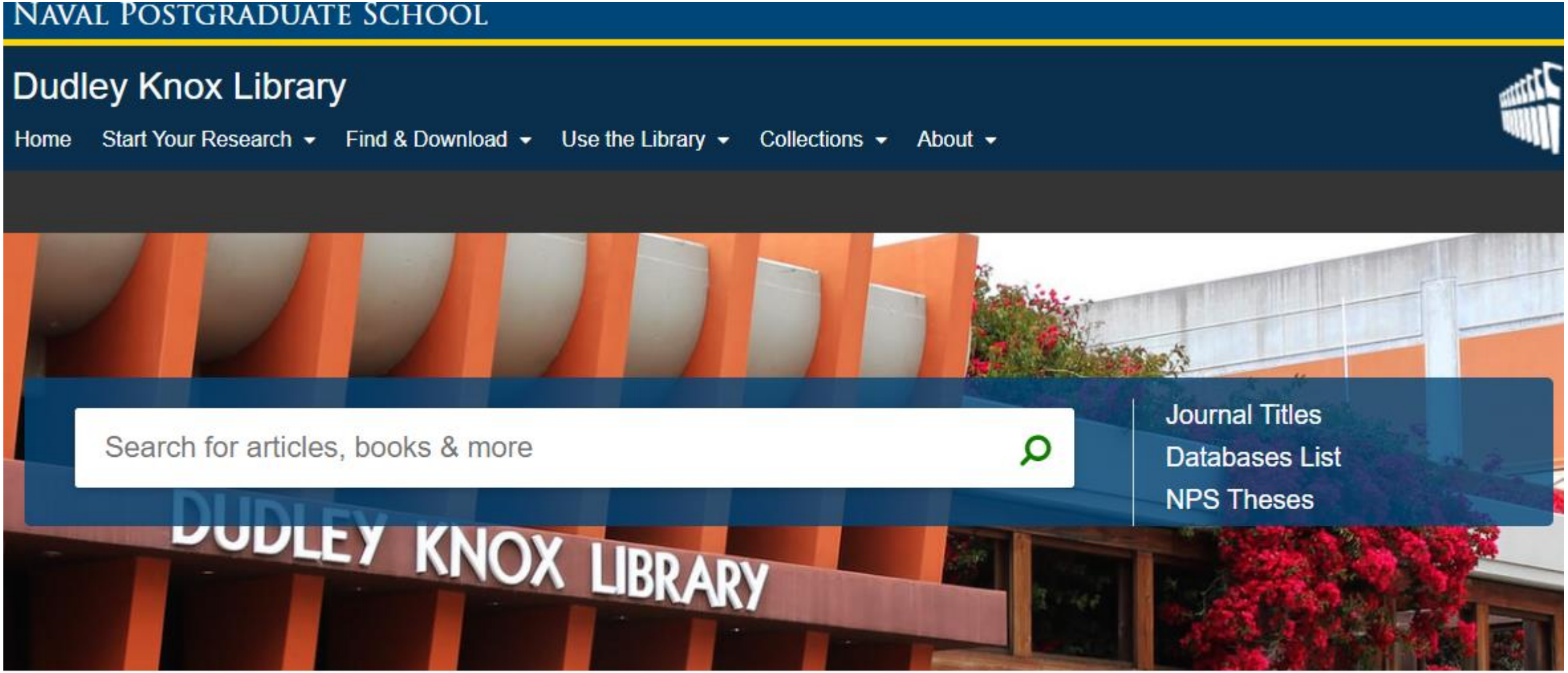

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Average weekly hours (Sunday-Saturday); extended hours during finals weeks	78	78	78	78	78	78
eResources available in library catalog (books, journals, reports & more)	391,486	377,192	589,377	587,296	640,051	966,484
eResources available in Restricted Collection (Restriced NPS Thesis, NPS Reports, etc.)	1,465	1,605	1,701	1,709	1,946	2,053
eResources in NPS Archive: Calhoun	43,703	49,549	53,788	58,732	63,132	63,758
On-site Library visits	313,199	280,376	281,393	272,037	260,761	108,457
Average daily library visits (on-site)	909	808	842	829	1,014	1,063
Average daily library visits (virtual)*	--	4,737	4,813	1,746	2,011	1,587
Hours students used collaborative study spaces	>8,200	8,164	24,051.75	28,267.25	28,851	12,376.50
Students receiving library instruction	2,746	2,435	2,501	2,432	2,191	1,968
Library instruction sessions offered (face-to-face and virtual)	146	126	138	149	134	118

*2018 changed to Google Analytics Sessions for counting virtual visits

Knox Library Statistics

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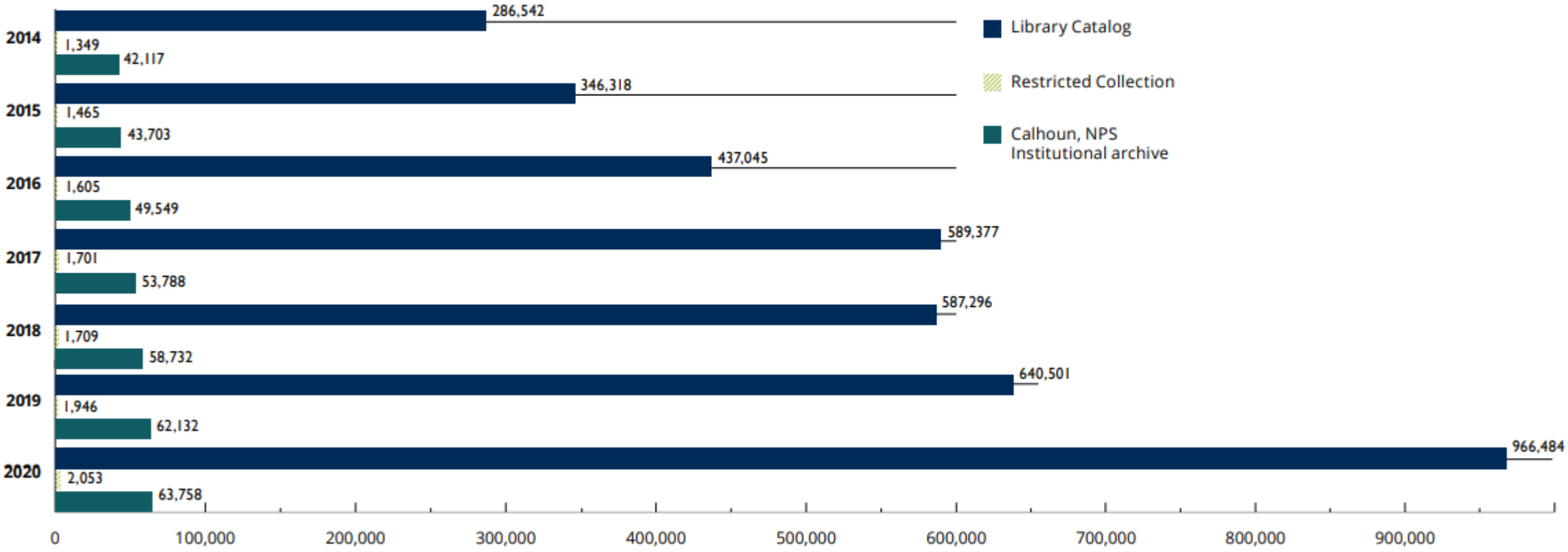

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  From the National Geophysical Data Center, these global bathymetric and topographic data sets and visualizations can be used for a wide variety of scientific, practical, and artistic applications
- Pacific Sea-Floor Mapping
  USGS
  These maps show the bathymetry of the seafloor surrounding San Francisco, Santa Monica, and the Hawaiian Islands. Images include back scatter, shaded relief, stereo relief, and a perspective view.
- Office of Coast Survey - National Oceanic and Atmospheric Administration
  Nautical Charts & Publications
- World Atlas - Oceans
  Oceans by size, depths and planet Earth details

Data Resources

- Central and Northern California Ocean Observing System (IOOS)
  A collaborative that enables sustained and coordinated measurements, model nowcasts and forecasts, and integrated products. Part of a national framework of integrated coastal observing systems covering all coastal areas throughout the United States.
- Coastal Data Information Program (CDIP)
  Coastal environmental data
- Data Access Viewer (NOAA)
  Elevation, imagery, and land cover data for the coastal U.S. and its territories
- Marine Geoscience Data System (MGDS)
  A suite of tools and services for free public access to marine geoscience research data acquired throughout the global oceans and adjoining continental margins
- National Data Buoy Center (NOAA)
- Naval Meteorology & Oceanography Command (Public)
  The Joint Typhoon Warning Center (JTWC) is the U.S. Department of Defense agency responsible for issuing tropical cyclone warnings for the Pacific and Indian Oceans.

  The Fleet Numerical Meteorology and Oceanography Center (FNMOC) provides the highest quality, most relevant and timely worldwide

Maritime Security & Violence

Search this Guide Search

This guide is primarily in support of the Institute for Security Governance (ISG) program. It is intended to help ISG students (and others) find open source materials related to maritime violence, terrorism, and piracy information.

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Ocean Piracy

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Maritime Terrorism

Maritime Threats

Capture at Sea

Subject Guide

Greta E. Marlatt

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- EC Maritime Security Strategy
- European Union Maritime Security Strategy
- IMO - Implementing Sustainable Maritime Security Measures in West and Central Africa
- National Strategy for Maritime Security
  UK Ministry of Defence
- Somali Maritime Resource and Security Strategy
- Strategy for the Danish Counter-Piracy Effort 2011-2014
- UNODC Maritime Crime Programme

Threat Reports

- Anti-shipping Activity Messages (ONI)
  Anti-shipping Activity Messages (ASAM) include the locations and descriptive accounts of specific hostile acts against ships and mariners
- Global Maritime Risk
- International Maritime Bureau (IMB) Live Piracy & Armed Robbery Report
- NATO Shipping Centre Weekly Update
- ONI Maritime Shipping Threat Reports
- ReCAAP Consolidated Incident Reports
  Interactive incident reports
- ReCAAP Incident Reports

Miscellaneous

Congressional Hearings & Reports

- Global Maritime Piracy: Fueling Terrorism, Harming Trade [hearing-2011]
- Gulf of Guinea: Recent Trends in Piracy and Armed Robbery [CRS]
- How to Improve the Efficiency, Safety, and Security of Maritime Transportation: Better Use and Integration of Maritime Domain Awareness Data [hearing-2013]
- LNG as a Maritime Fuel: Prospects and Policy [CRS]
- Maritime Security: Potential Terrorist Attacks and Protection Priorities [CRS-2007]
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- Piracy off the Horn of Africa [CRS-2011]

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India	299,397	88,840	388,237
France	254,602	189,560	444,162
United Kingdom	217,020	265,735	482,755
Ukraine	159,009	38,368	197,377
Philippines	140,711	73,224	213,935
Japan	130,271	61,079	191,350
Canada	126,482	83,981	210,463

2021-09

ANALYZING EMERGENT BEHAVIOR OF SUPPLY CHAINS FOR PERSONAL PROTECTIVE EQUIPMENT IN RESPONSE TO COVID-19

Beaver, Joshua P.

Monterey, CA; Naval Postgraduate School

http://hdl.handle.net/10945/68296

ABSTRACT

The novel coronavirus (COVID-19) revealed weaknesses in supply chains of companies that produce personal protective equipment (PPE), resulting in nationwide shortages. A government-industry collaborative platform between the National Institute for Standards and Technology (NIST) and Helpful Engineering is under development to act as an exchange for material and equipment at each level of the supply chain. The intent of this is to create an online agile production platform (APP) for PPE. There is a need to proactively limit negative interactions with the APP. The creators of the APP constrain bad behavior or abuse of the system using a "bottom up" approach of coding requirements. In tandem, a "top down" approach of the system is modeled using Monterey Phoenix, a behavioral modeling platform. Stakeholders and processes are modeled to show different permutations of interactions. Impossible scenarios are removed with model constraints. The remaining traces are analyzed for emergent behavior and compared with the constraints programmed into the model. Findings of this research include unexpected emergent behavior in two scenarios. One scenario explored delivered quality to the customer, and analysis exposed a gap that allowed counterfeit parts into the APP. The other scenario explored how the APP managed the supply chain. Weaknesses that allowed missed inspections to pass bad parts were also found. The models developed will drive changes that increase confidence in the APP.

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A. RECOMMENDATIONS

Supply chain experts were utilized to provide analysis of the models and recommendations to proactively protect the APP against the unexpected emergent behavior found. More direct and effective controls could be implemented on a product-by-product basis. These recommendations are tailored at a strategic level for incorporation across the APP's enterprise to reduce the likelihood of the undesired emergent behavior.

The transportation and delivered quality model exposed some weaknesses but also showed opportunities to strengthen the system. First, there should be a customer feedback system for product that does not arrive as expected or perform as intended. That feedback can be analyzed for trends to expose problem suppliers. The APP can use this to impact positive change or remove them from the system as an approved supplier.

For possible counterfeit concerns, it is recommended that the APP require suppliers to abide by ISO 16678, guidelines for interoperable object identification and related authentication systems to deter counterfeiting and illicit trade (International Electrotechnical Commission and International Organization for Standardization 2018). PPE from a new APP supplier could also be validated by an FAI and/or third party to show conformance to critical characteristics and parameters prior to shipment to the customer. This may not be necessary for all PPE, but critical systems that utilize electronics and circuit cards which are highly susceptible to counterfeit such as ventilators could benefit.

B. FUTURE RESEARCH OPPORTUNITIES

This thesis may be applicable to other supply chain interactions, especially those where an entity acts as an integrator and may not have direct control over all sources. A comparable research opportunity may exist for Department of Defense (DOD) acquisition teams acting as the Lead Systems Integrator (LSI) of a system. These models could be tailored to match the supply chain of the system with additional detail specific to that environment. A supply chain SME could review the traces and determine if unexpected behavior exists within that system.

Another opportunity is to continue researching the maturation of the APP as it is developed and implemented. These models could be used as the basis, and then tweaked with any recommendations the APP team incorporates. Another iteration of models and analysis could be conducted to refine the system and find more emergent behavior since the APP system will have less degrees of freedom in the future.

Alternatively, this modeling methodology could be applied to the worldwide vaccination effort against COVID-19. Multiple companies utilizing their own supply chains are creating vaccine supplies for the entire world, and behavioral modeling could assist organizations in the procurement, storage, and distribution of the vaccine to maximize the effects to their population. Improvements in this system could benefit the populations of countries where the vaccine will not be abundant for some time, and countries that are mostly vaccinated but may need booster shots after an indeterminate amount of time to keep their population protected.

2021-06

SEA ASSURANCE: HOW CHINAS SPRATLY MILITARIZATION IMPACTED GREAT POWER COMPETITION

Box, Aaron B.

Monterey, CA; Naval Postgraduate School

ABSTRACT

By creating islands in the Spratlys and placing airfields, radars, and missiles on them, China fundamentally changed Great Power Competition (GPC). To measure and understand these changes within relevant policy communities, this thesis asks two questions: First, how did Spratly militarization impact U.S-China competition within GPC using a diplomatic, information, military, and economic (DIME) framework? Second, how did Spratly militarization affect maritime strategy?

Using data within each DIME category and scholarly analysis, this thesis finds that Spratly militarization significantly impacted competition informationally and militarily but with lesser impact to diplomacy and economics. Within maritime strategy, Spratly militarization displayed an entirely new concept that this thesis defines as sea assurance. Using this new terminology, this thesis finds that Spratly militarization provided China with ability to protect or control more than half of the South China Sea, including a major sea line of communication and multiple maritime chokepoints.

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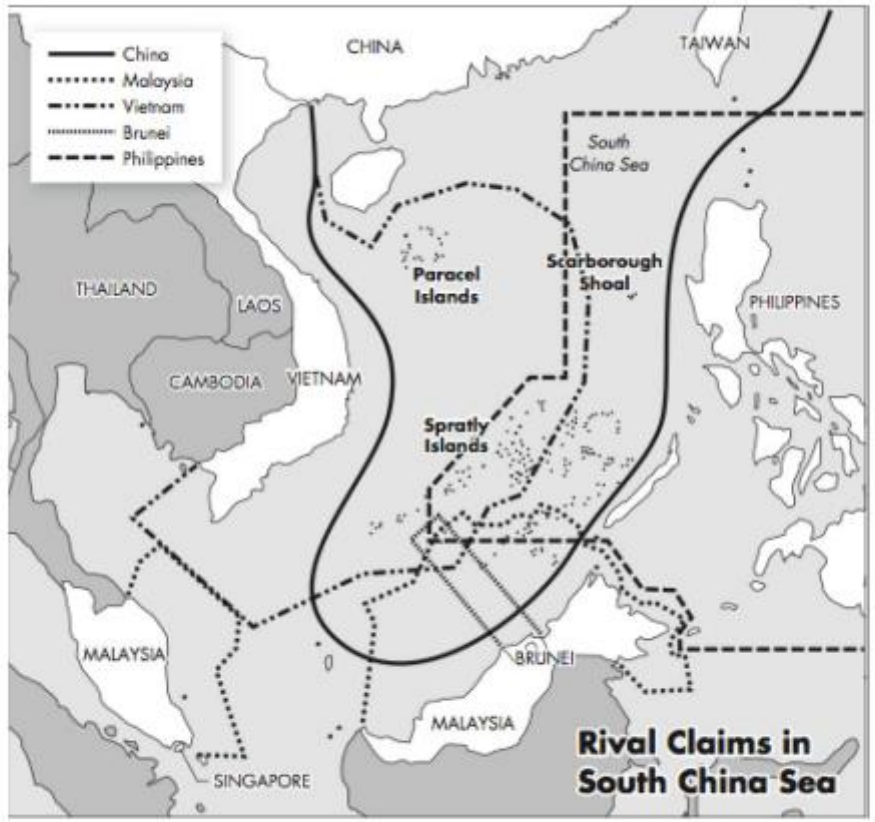

Figure 1. Rival Claims in the SCS[20]

utilized for military purposes once airfields were complete. Figure 3 shows dredging operations at Fiery Cross and is a good representation of what dredging operations looked like on all features.

Figure 3. Fiery Cross Reef Dredging, 2014 (left and center) to 2015 (right)[79]

As the result of dredging operations in 2014 and 2015, China created seven new islands.[80] As depicted in Figure 3, the features of the Spratly Islands were mostly underwater at high tide; China used multiple dredgers to move sand up to create dry land. Johnson Reef, a smaller feature near the center of the Spratly Islands, was the first new feature dredged in January 2014.[81] Hughes Reef, near the center of the Spratly Islands, and Cuarteron Reef, the southernmost feature, were dredged starting in March 2014.[82] Fiery

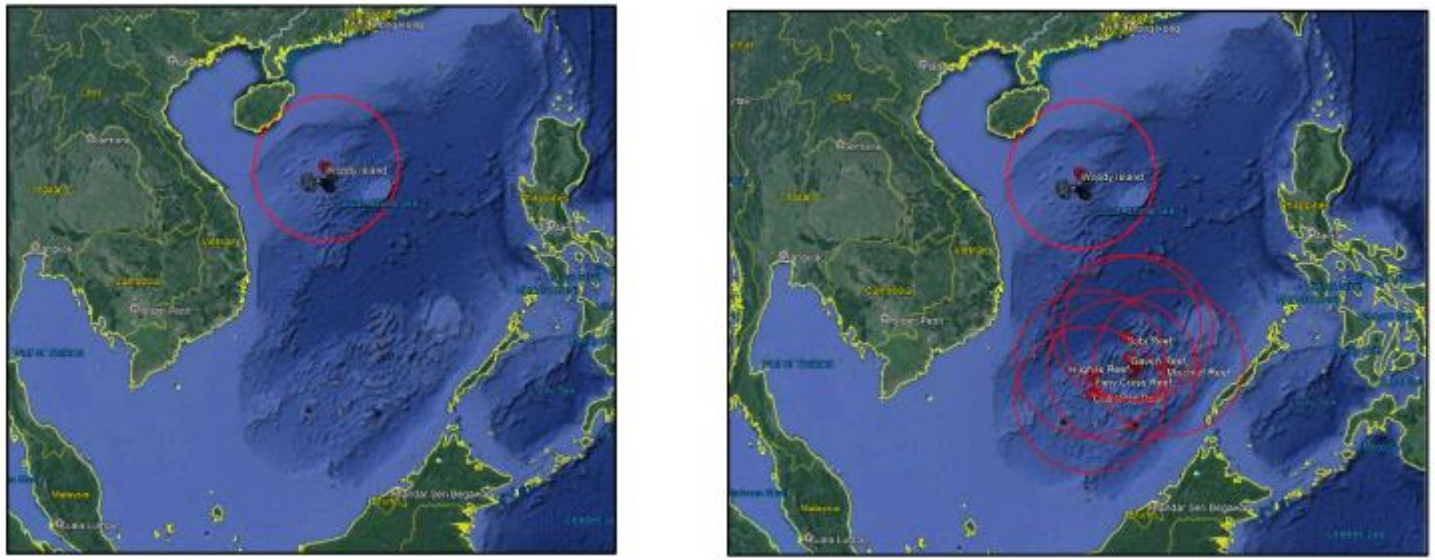

Figure 6. SCS Radar Coverage before (left) and after (right) Militarization[128]

In addition to ground-based radars, the airfields on the Big Three outposts provide China with the capability to conduct airborne ISR. China's primary ISR aircraft is the Y-8 with an approximate range between 700 and 3,000 nautical miles depending on payload.[129] The new version of the Y-8 is the Y-9 with a range between 1,300 and 2,100 nautical miles.[130] To account for variation between aircraft type and payload, Figure 7 uses 1,000 nautical miles for ISR coverage range (500 NM out and 500 NM back).

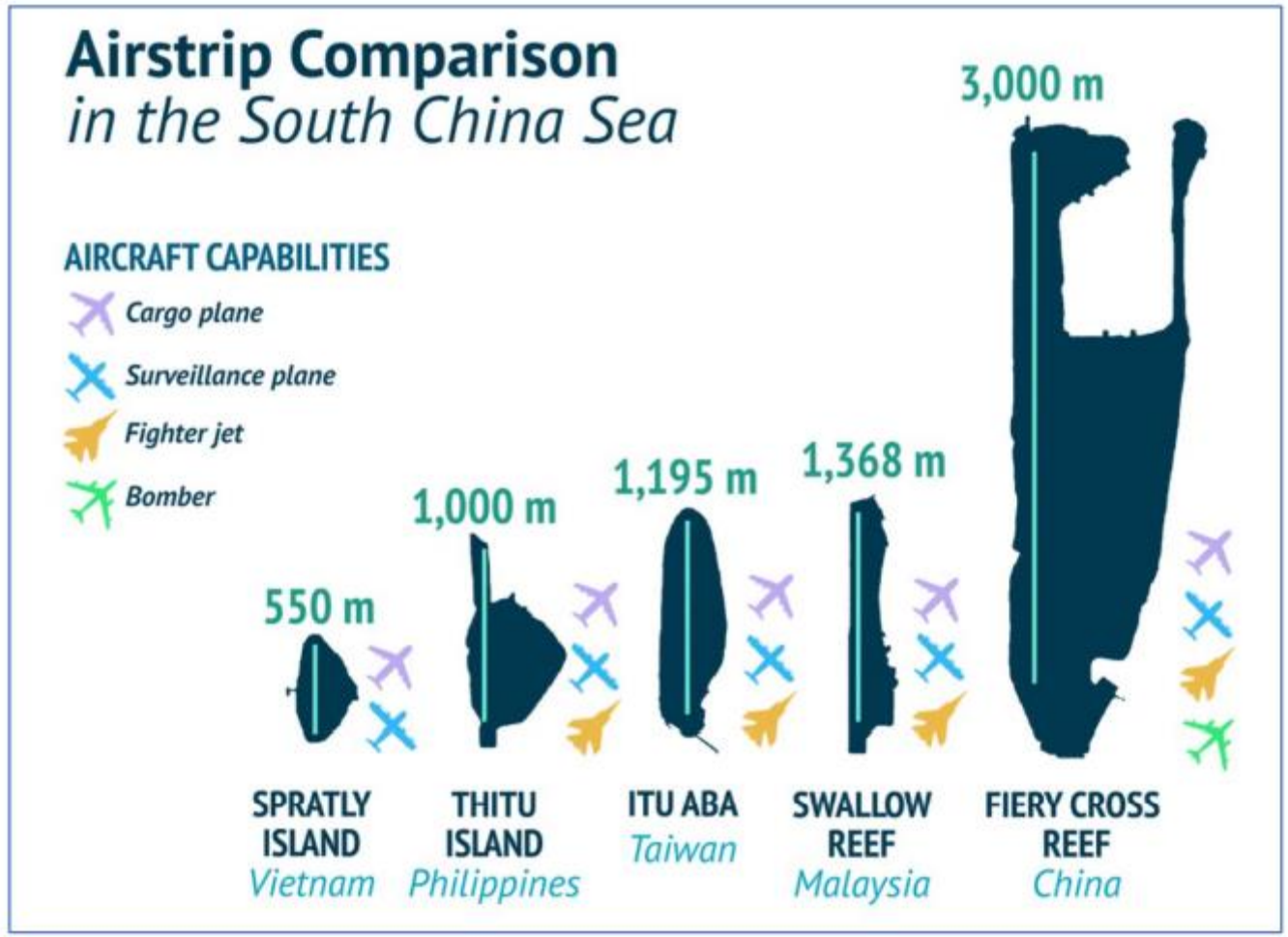

Figure 9. Comparison of Airstrips in the SCS[146]

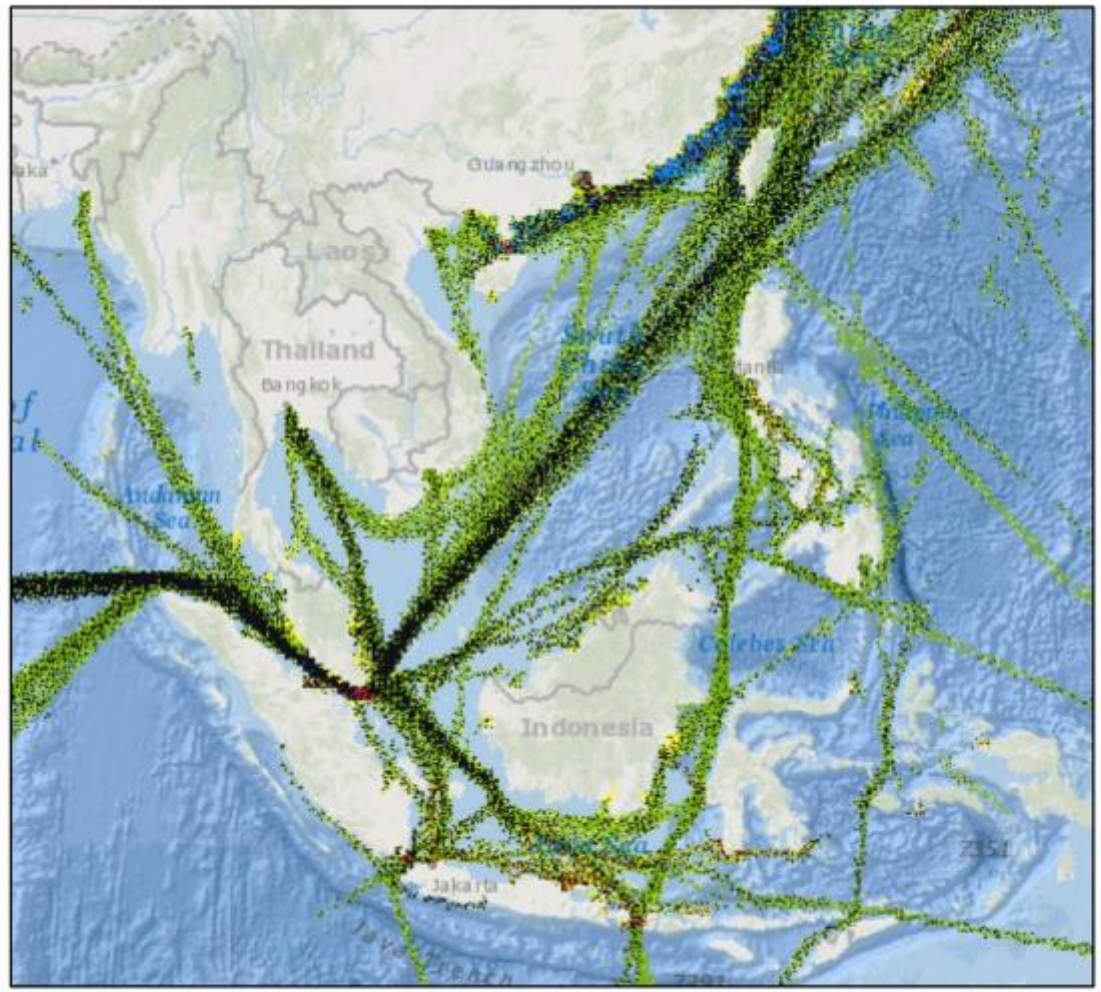

Figure 13. SCS Maritime Traffic Density (2016)[161]

B. IMPLICATIONS FOR UNITED STATES POLICY

The findings of this thesis provide two valuable insights for United States policy: first, they help to understand China's strategic trajectory in the SCS; and second, they suggest options for United States strategy in the SCS and elsewhere.

China's coercive strategy of militarizing disputed areas shows no sign of stopping. China's behavior in the Paracels and Spratlys suggests China intends to establish sea assurance over the entire SCS, possibly by militarizing Scarborough Reef and Macclesfield Bank. As discussed in Chapter III, United States neutrality on sovereignty issues in the Spratlys weakened other claimants' ability to resist Chinese coercion.

To bolster relationships with its ASEAN partners, the United States should seek to deter China from further militarization of the SCS as well as increase sea assurance capabilities of the other Spratly claimants. By assisting other Spratly claimants in militarization of their own outposts, the United States could lead China to lose its monopoly on control of the region. One typical method the United States uses to limit China's perception of control over a sovereign, archipelagic territory is through Freedom of Navigation Operations (FONOP).[179] While United States FONOPs demonstrate a great power's ability to transit non-sovereign territory, they have not prevented China from increasing its military capability in the region (e.g., YJ-12 ASCMs placed on the Big Three

Future research should consider historic examples that may apply to the criteria provided in this thesis and challenge the assertion made here that China's actions in the Spratly Islands are unique. Furthermore, future research should evaluate the usefulness of sea assurance as a concept. Future research should examine potential ways for nations to achieve sea assurance. A number of developing technologies offer great power competitors the opportunity to create weapon systems with greater range, more efficient power consumption (e.g., nuclear and solar), and with limited or no personnel involved (autonomous and unmanned systems). These technologies combined have the potential to turn futuristic concepts of defense into reality. Finally, beyond the sea, future research should evaluate assurance in other domains. The key components of sea assurance—permanence, peacetime, and disputed/international—also exist in air, space, and cyber domains. What would assurance in those domains look like and have they been attempted? Developments in space perhaps pose the best example of nations attempting to find cooperation regarding military activities in international domains.[184] Competition between the United States and China is likely to persist in all domains for at least the next century. Future research should seek to be policy-relevant and focus on ways to achieve desirable outcomes.

Benefits of Naval Postgraduate School Resources

- Learning about this institution's history and its historical and ongoing role in American professional military education.
- Learning about NPS admission requirements.
- Learning about institutional curricular and research programs.
- Gaining enhanced awareness of NPS' role in promoting professional development and scientific and strategic knowledge of naval and maritime subjects.
- Learning how emerging leaders in the U.S. and allied navies and governments view emerging naval and maritime matters.
- Gaining heightened appreciation of the ongoing importance of NPS instruction and research and how they impact historical, current, and emerging public policy issues.
- Gaining enhanced awareness of how NPS research is relevant to the increasing economic and strategic importance of the Indo-Pacific region which may become an arena of international military conflict.
- Questions?