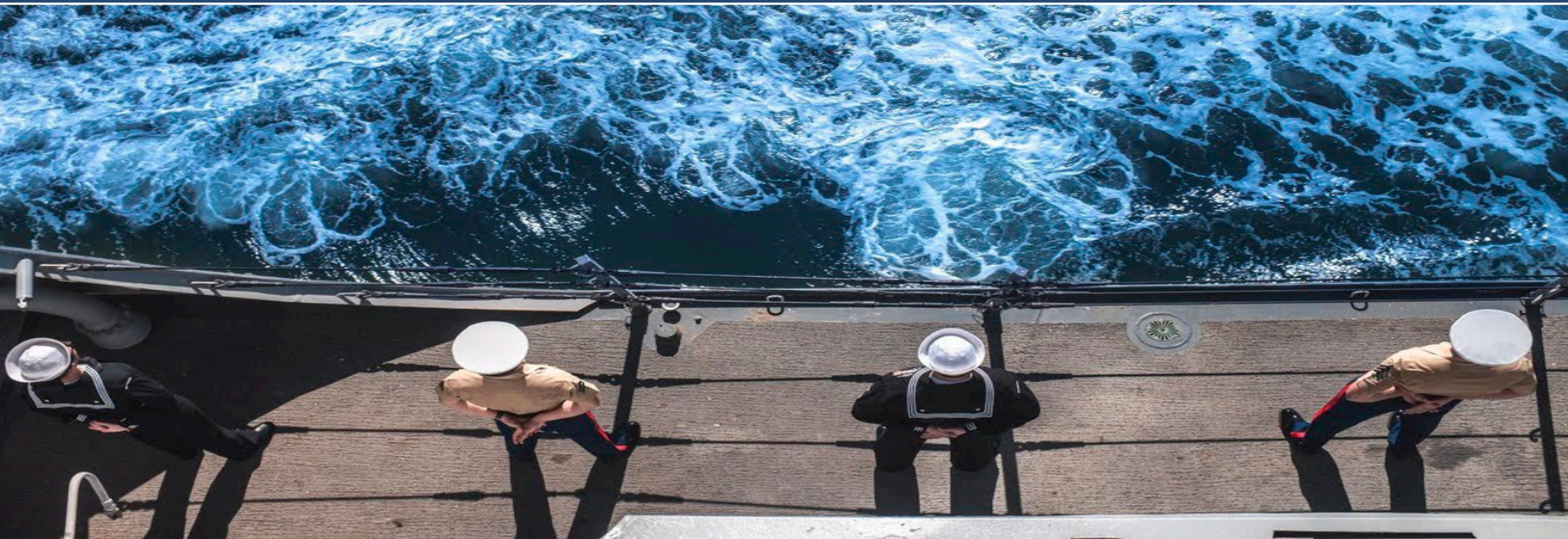




NAVAL
POSTGRADUATE
SCHOOL

Crew Endurance Research Directory FY 2021



Introduction

Since 2001, the Crew Endurance Team at the Naval Postgraduate School has conducted research into factors that impact the health, performance, and readiness of the warfighter, setting new standards for safety and effectiveness.

As a direct result of our research, circadian-based watchbills have been implemented across the fleet, providing USN Sailors with protected sleep periods each day. Going forward, our research will continue to focus on ways to optimize human performance in operational settings.

Research Areas

Optimization of human performance is at the core of all our efforts. We tailor our research to the needs of the communities who request our help. Based on data collected on over **35 surface combatants** of the US Navy and **around 6,500 Sailors**, our current research includes the following projects:

- Circadian-Based Watchbills
- Crew Endurance Training
- HEV Light Management for Shiftwork and Circadian Entrainment
- SMART Risk Assessment Tracking Tool
- Problematic Video Gaming
- Sleep Inertia Mitigation
- Stress Inoculation Training
- Nutrition and Dietary Patterns of USN Sailors



Circadian-Based Watchbills

A "circadian-based watchbill" is a work and rest schedule that conforms to a 24-hour day, allowing individuals to work, eat, and sleep at the same time each day.

When you combine the hours spent on watch with hours off watch (whether doing other work, eating, or sleeping), a circadian-based system adds up to 24 hours, aligning with the naturally occurring 24-hour rhythm which drives all biological processes, enabling personnel to perform at their best.

Avoid These Watchbills

Non-Circadian Watchbills

Work/rest cycle does not add up to a 24-hr day.
Work/sleep occurs at different times every day.

3 Sections:

5hrs-on/10hrs off
"Five and Dime"

3 Sections:

6hrs-on/12hrs off
"Classic Submarine
Schedule"

4 Sections:

5hrs-on/15hrs off

Our team designs, implements, and assesses innovative watchbills that support human circadian rhythms in operational environments.

We evaluate watchbills in operational settings to determine better schedules for shift workers.

NUMBER OF AVAILABLE SECTIONS

Use These Watchbills

Circadian Watchbills

Work/rest cycle adds up to a 24-hr day.
Work/sleep occurs at the same time every day.



Shorter
= Better*

↑
Shift Duration
↓

Longer
= Worse

2 Sections

6hrs-on/
6hrs off

7hrs-on/
5hrs off

12hrs-on/
12hrs-off

3 Sections

4hrs-on/8hrs off
(no dog watches)

Day 5/Night3
D5/N3

8hrs-on/
16hrs-off

4 Sections

3hrs-on/
9hrs off

6hrs-on/
18hrs off

Number of Sections

Fewer = Worse**

Short-term solution only
to get qualified watchstanders.

More = Better

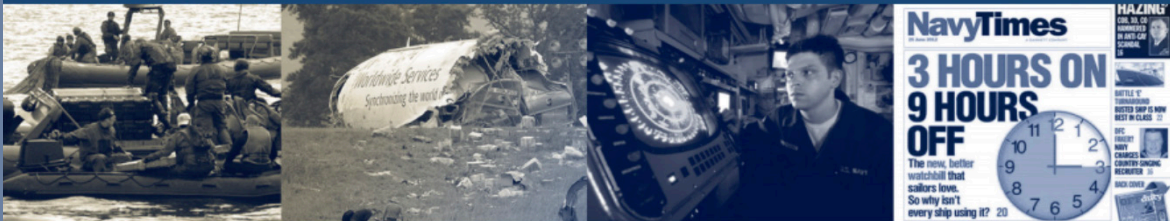
Improves performance
and safety.

Crew Endurance Training

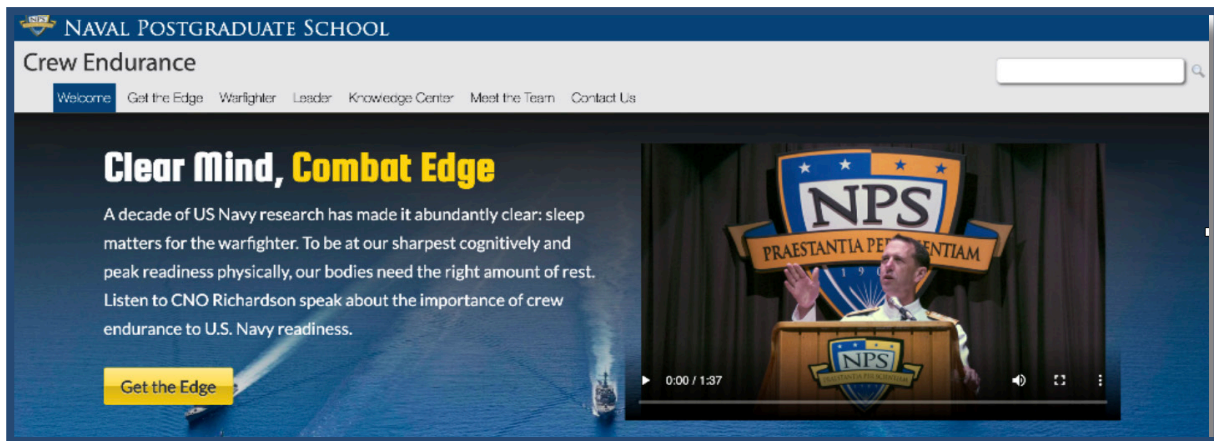
We develop and deliver crew endurance training tailored to the specific needs of various naval communities. We provide crew endurance handbooks to commands to help them plan their work and rest schedules.



CREW ENDURANCE HANDBOOK A Guide to Applying Circadian-Based Watchbills



By designing online, computer-based delivery systems, we can more easily provide crew endurance training to the fleet using resources like the Crew Endurance website.



The screenshot shows the top portion of the NPS Crew Endurance website. At the top left is the NPS logo and the text "NAVAL POSTGRADUATE SCHOOL". Below this is the page title "Crew Endurance" and a search bar. A navigation menu includes "Welcome", "Get the Edge", "Warfighter", "Leader", "Knowledge Center", "Meet the Team", and "Contact Us". The main content area features the heading "Clear Mind, Combat Edge" in white and yellow text. Below the heading is a paragraph: "A decade of US Navy research has made it abundantly clear: sleep matters for the warfighter. To be at our sharpest cognitively and peak readiness physically, our bodies need the right amount of rest. Listen to CNO Richardson speak about the importance of crew endurance to U.S. Navy readiness." A yellow button labeled "Get the Edge" is positioned below the text. To the right is a video player showing a man in a military uniform speaking at a podium with the NPS logo and the motto "PRAESTANTIA PERSEVERANTIAM". The video player shows a progress bar at 0:00 / 1:37.

NPS Crew Endurance Website
www.nps.edu/crewendurance

SMART Risk Assessment Tracking Tool

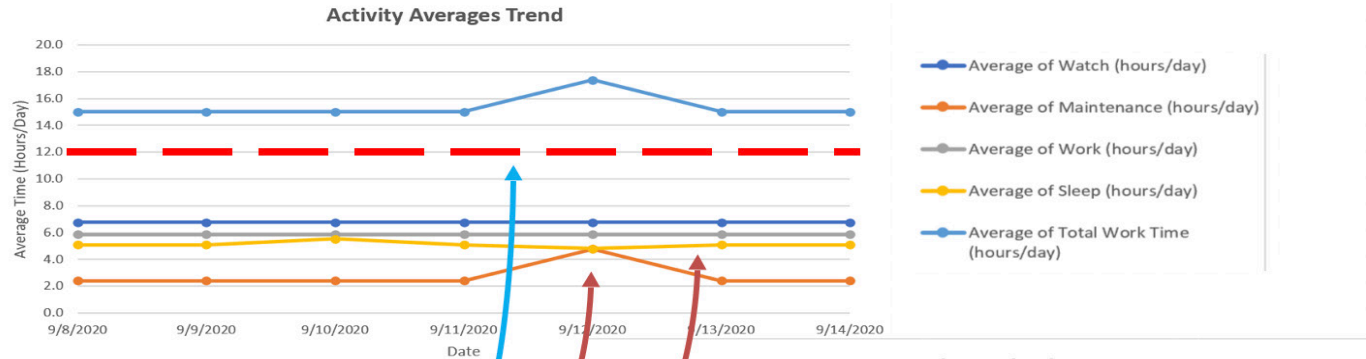


The Scheduling Management Aid for Risk Tracking (SMART) allows leaders and commands to track and manage risk more effectively – for the entire Ship, by Department, Division or the individual Sailor. Currently, SMART runs in Excel, making it available for immediate use at no additional cost.

WATCH STANDER	WATCH/REST RATIO	EXPERIENCE	CREW COHERENCE	EQUIPMENT	IRM
OOD: LT Smith	2	4	4	3	12
JOOD: LTJG Jones	3	2	3	3	10
QMOW: QM1 Door	2	1	2	3	8
Helm: BM3 Anderson	3	4	4	3	12
Lee Helm: BMSN Wray	3	1	1	3	9
Total/Average	13	12	14	15	Avg 10

The tailorable algorithm behind the SMART dashboard enables visualization of the notional fatigue level of the crew based on prior work and rest history.

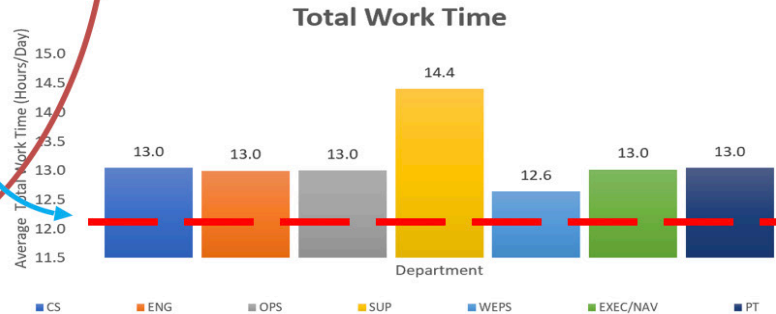
By identifying individuals at higher risk levels, watchbill substitutions can be made that will reduce risk, improve safety, and increase overall mission effectiveness.



Greater than 12-hour workdays

Maintenance activity spike

Sleep below 7-hour recommendation



HEV Light Management for Shiftwork and Circadian Entrainment



Photo: Courtesy of Magnus Wennman

This project investigates the use of HEV light-blocking glasses and HEV light-emitting devices on sleep and fatigue levels.

We explore how to speed up circadian entrainment so that circadian rhythms are aligned with work schedules, reducing fatigue and increasing alertness. Findings are especially important for communities with night shifts, for example, aviators who are required to rapidly shift from day flights to night flights.



Blue-blocking lenses can be useful in protecting circadian rhythms and stabilizing them for night watchstanders or for crews operating at extreme latitudes with long days/nights.

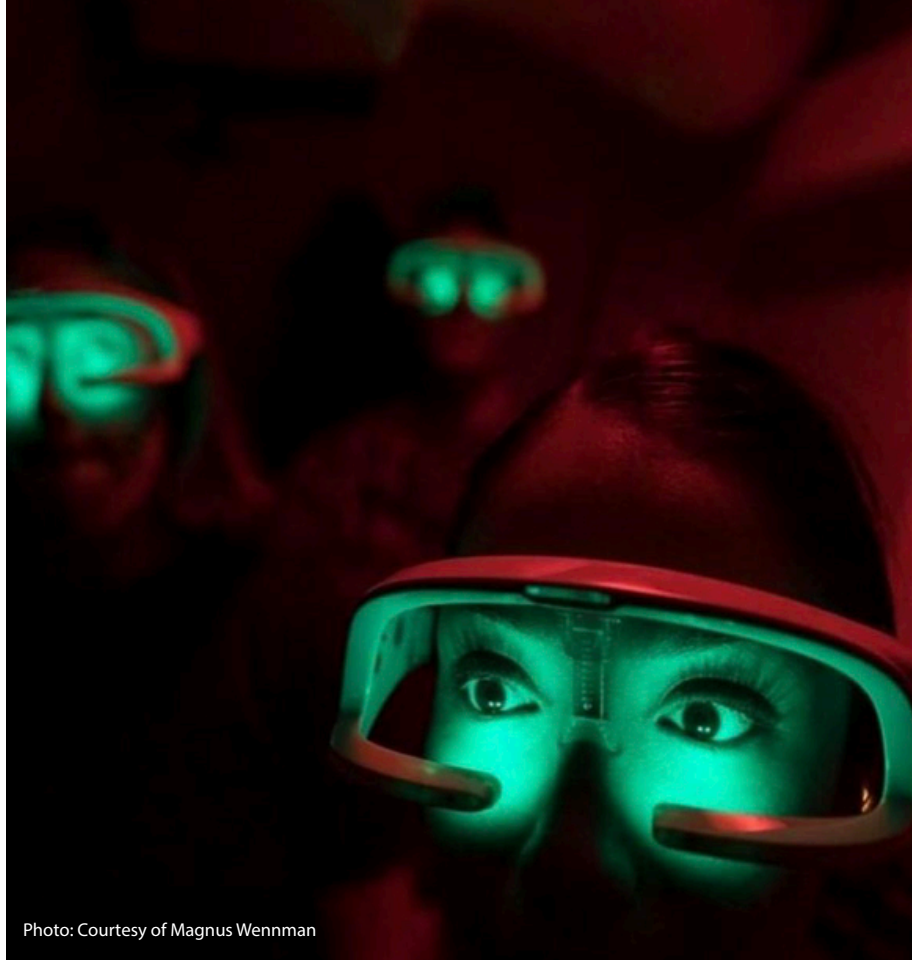
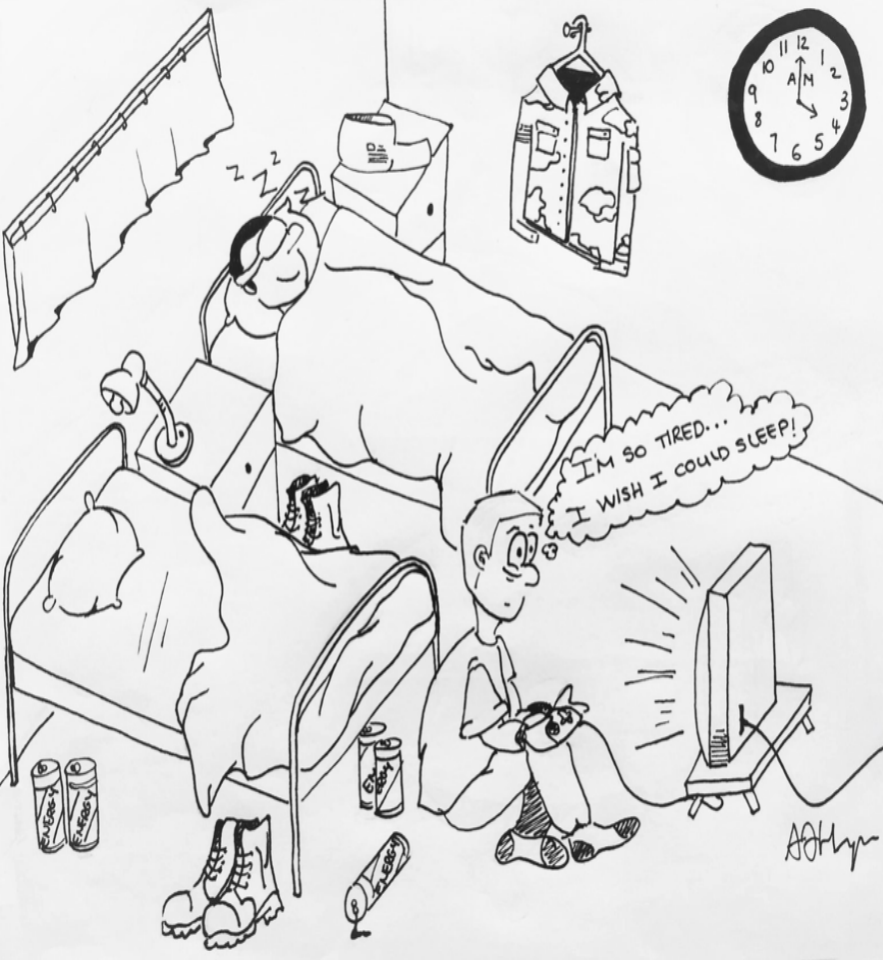


Photo: Courtesy of Magnus Wennman



Problematic Video Gaming

A significant percentage of military service members play video games. However, video gaming can lead to high stress levels, lower psychosocial well-being, higher levels of depression, and more aggressive behavior.

Our project examines problematic video gaming in USN Sailors and US Marines, assessing the prevalence of video gaming, exploring factors associated with this activity, and examining its effects on service members' well-being.





Sleep Inertia Mitigation

Sleep inertia is that groggy and sluggish feeling of disorientation that one experiences upon awakening and is especially noticeable when awakening from deep stages of sleep. It is of particular concern in military operations where unanticipated events require personnel to awaken unexpectedly and immediately make critical decisions at any hour.

In our lab, on-going collaborative efforts with NASA-Ames and University of South Australia are identifying and testing mitigation strategies to reduce sleep inertia when individuals are awakened from deep sleep.

Shipboard Habitability

HEV Light Canvases

Our team is designing and assessing new methods to deliver HEV light to promote alertness and stabilize circadian rhythms in workspaces such as Combat Information Centers. We are also exploring new designs and technologies to improve shipboard habitability.

Berthing

We are installing and assessing new designs and technologies, such as innovative rack curtains for sleeping quarters that limit light exposure and reduce noise.





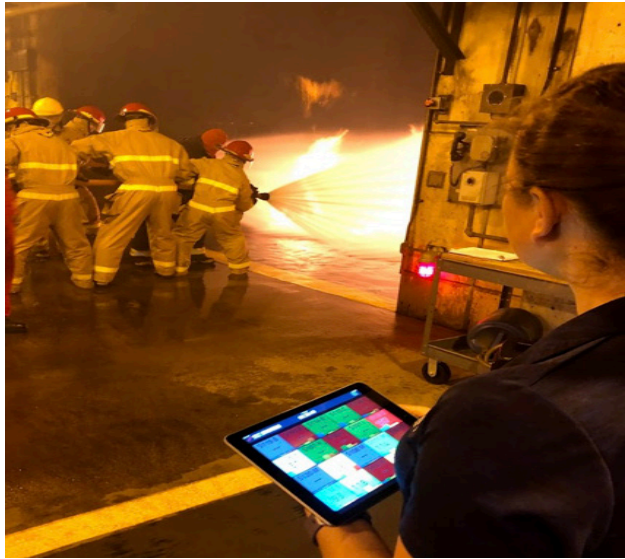
Stress Inoculation Training

The demands of military life – fatiguing daily schedules, prolonged family separations, and dangerous operational settings – can lead to overwhelming levels of stress.

Stress Inoculation Training (SIT) programs teach individual coping skills to better manage anxiety and stress levels when working in high-stress environments.

In the HSI Laboratory

The cold pressor stress test (foot in ice bucket) is being used to train individuals to manage stress while operating the ship bridge simulator.



Surface Warfare Officer School (SWOS), Newport, RI

Using simulators, students are exposed to high levels of stress and taught about their unique stress responses. This training helps them continue performing when they encounter demanding and dangerous operational conditions.

Potential Research: Nutrition and Dietary Patterns of USN Sailors

Obesity among USN Sailors is a growing health concern. Diet and food intake are major contributing factors to health and performance, particularly when meals are consistently consumed at night and out of sync with the naturally occurring, 24-hour circadian rhythm.

Eating unhealthy foods at night increases the likelihood that the body will store those calories as fat, as opposed to burning them as energy.



Potential Research: Dark Adaptation and Melatonin Suppression

This study will assess how HEV light can be used to increase alertness while also protecting dark adaptation for night operations.



Potential Research: Shipboard Wearables for Monitoring Crew Health

Wearable technology offers the opportunity to monitor crew health and fatigue levels in real-time. Combining wearables with tools like SMART enables commands and leaders to visualize crew risk levels and make decisions based on the readiness status of their crews.



Human Systems Integration and Crew Endurance Team



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GET THE EDGE

www.nps.edu/crewendurance

