Building Physiology-Based Models for Predicting Performance Impairment

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- The views expressed in this presentation are those of the author and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.
- The study protocol was approved by the Naval Submarine Medical Research Laboratory Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects (UCONN No. H14-328).
- This work is supported by funding work numbers F1710 and F1704.
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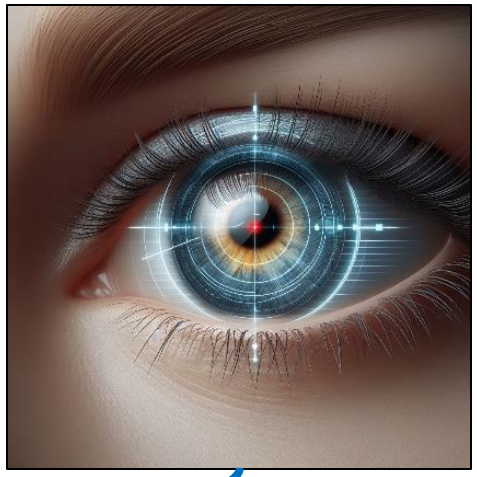
Goal

- Predict performance decrement due to fatigue
- Using noninvasive, nondisruptive monitoring
- To assist with watchstanding management

Background

Physiological Measurements During Operation

→

- **Visual Detection**
- **Working Memory**
- **Response Time**

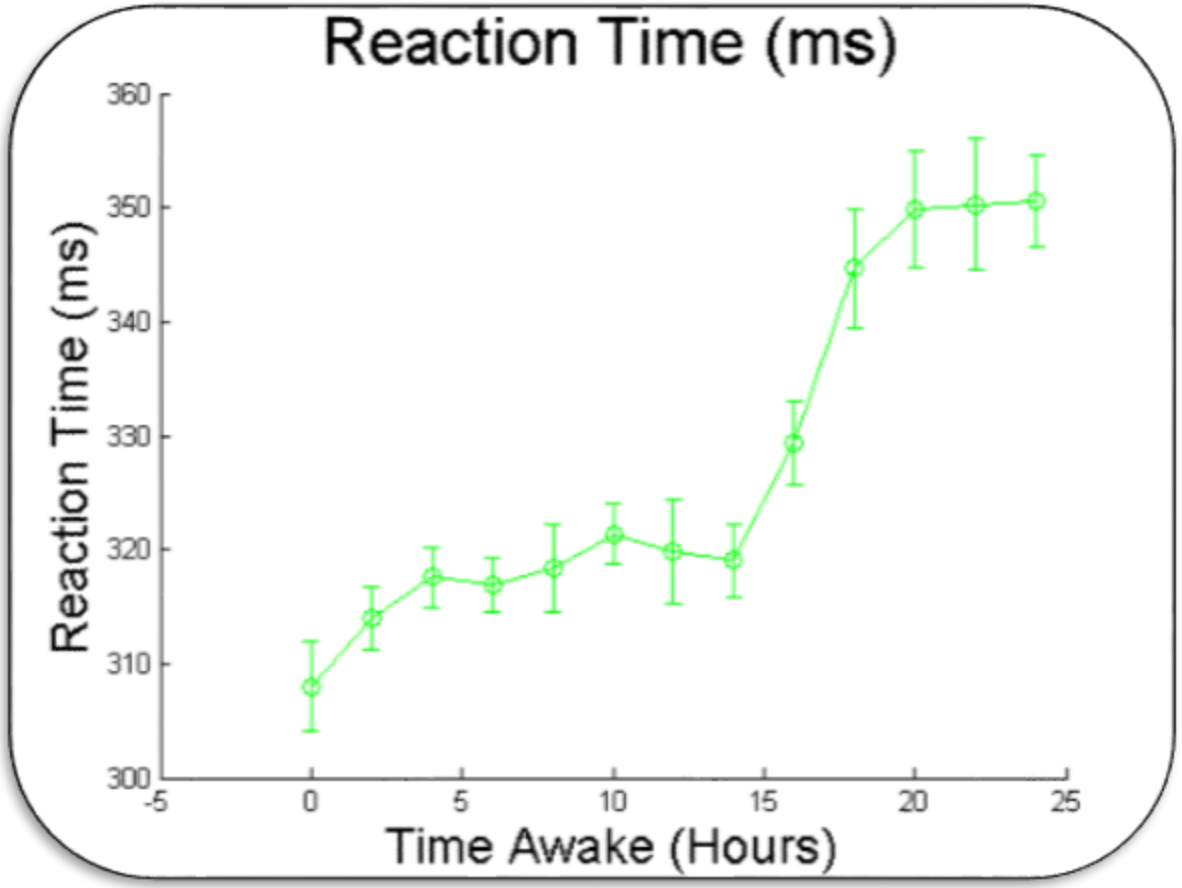
Predicted Changes in Cognitive Performance

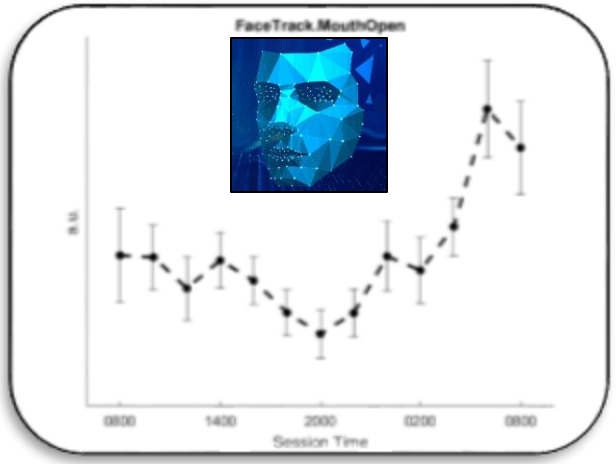
→

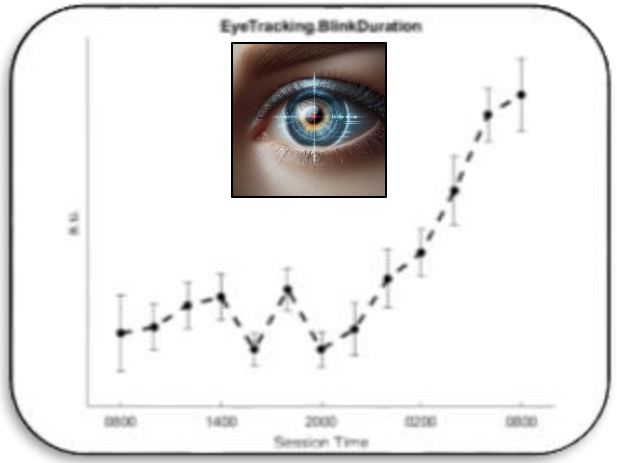
Recommendations for Watchstanding Management

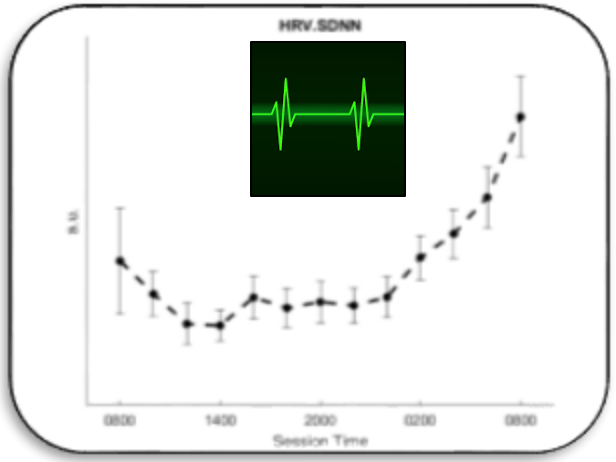
Image Sources: Microsoft Copilot, Wikimedia Commons

Biometrics and Performance Decrement









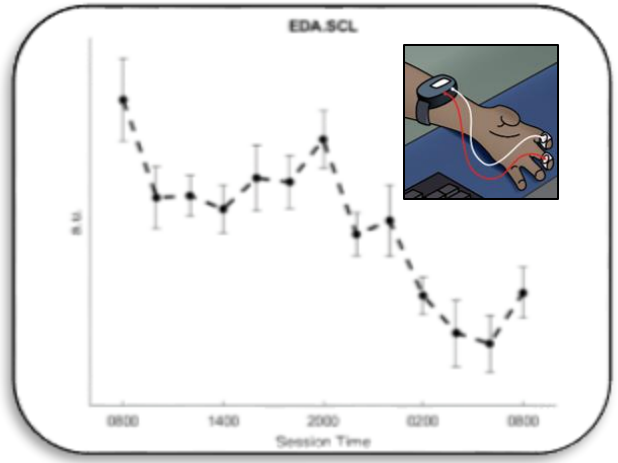
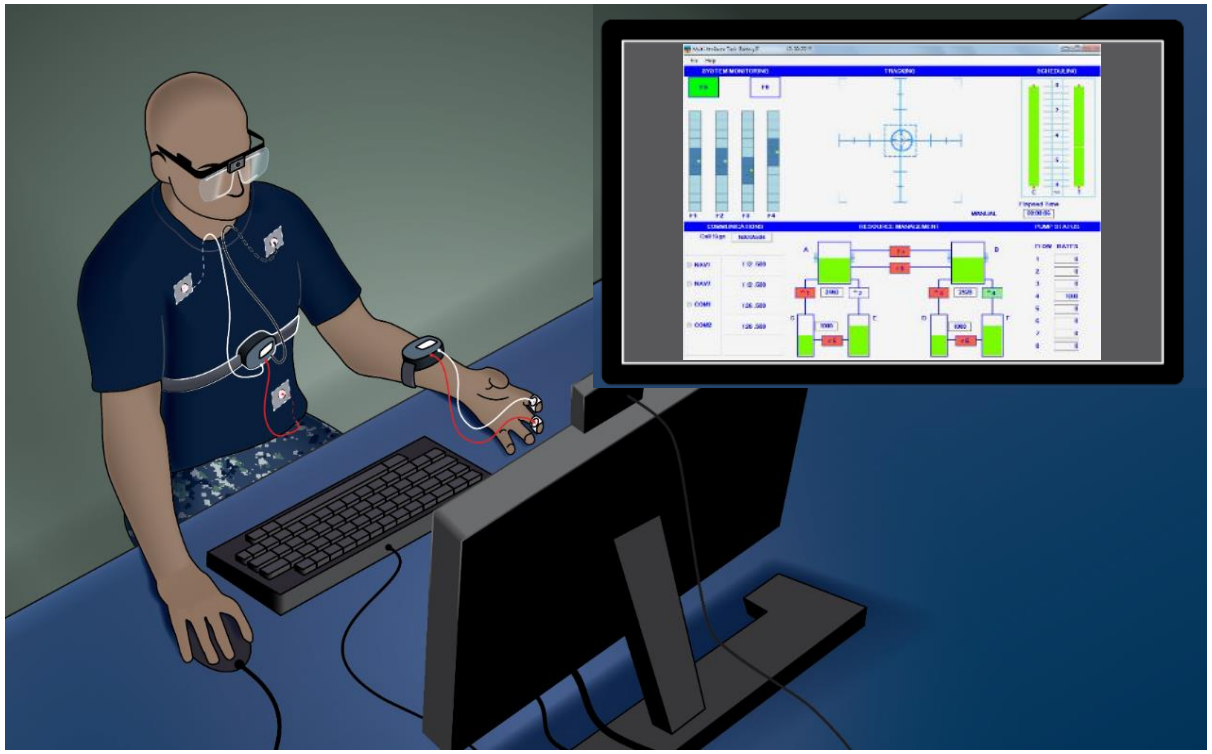


Image Sources: Microsoft Copilot, Wikimedia Commons

Studies and Non-Disruptive Monitoring

Multi-Modal Sensor Data Collection



Non-Invasive, Non-Disruptive Monitoring

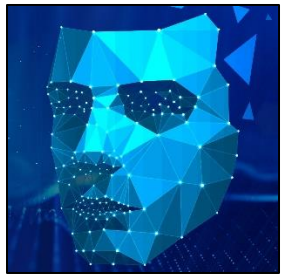
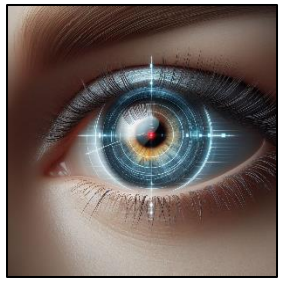
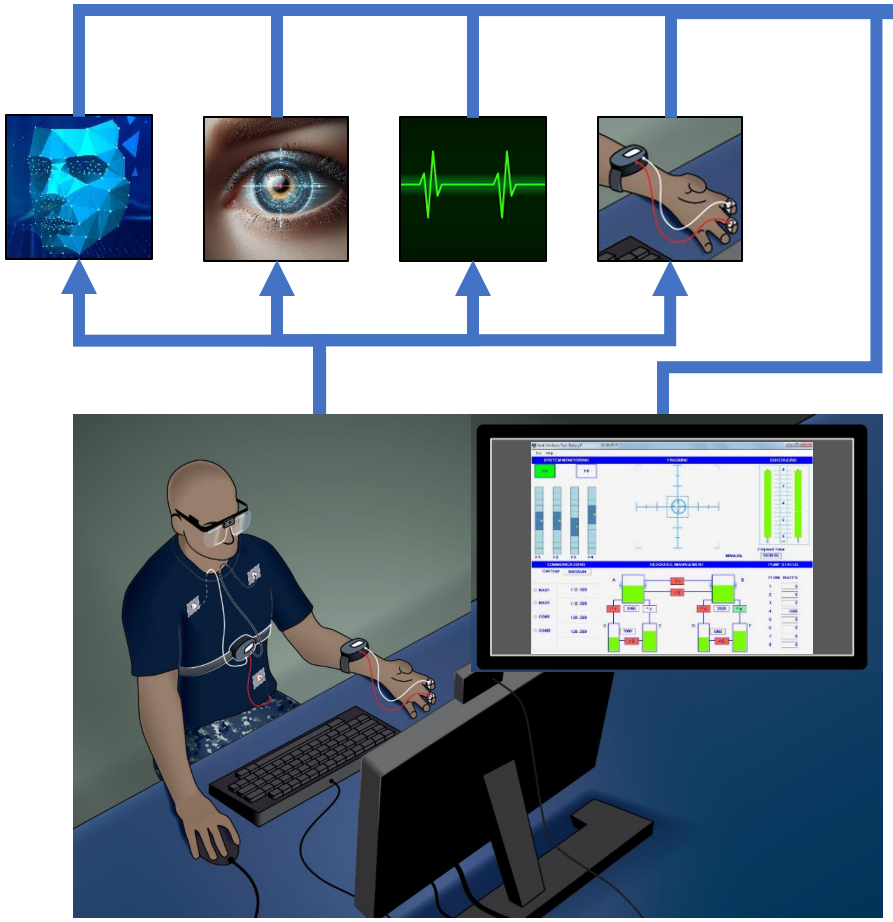



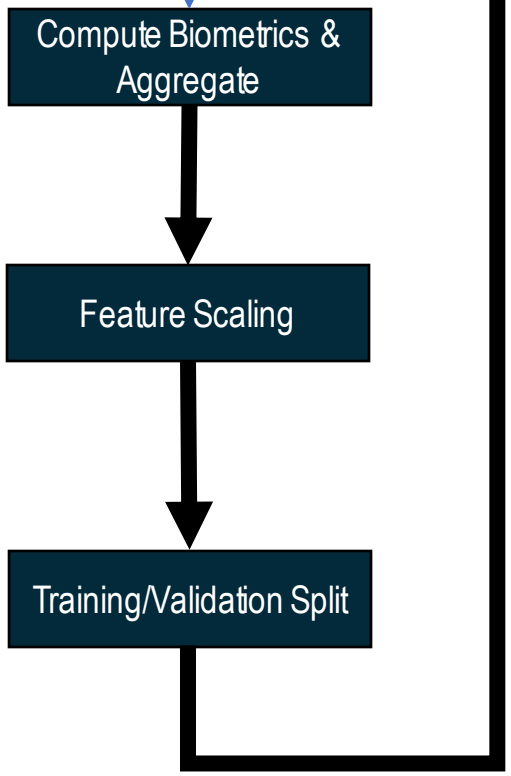




Image Sources: Logitech, Empatica, Tobii, Microsoft Copilot, Wikimedia Commons Internal

Methodology for Prediction





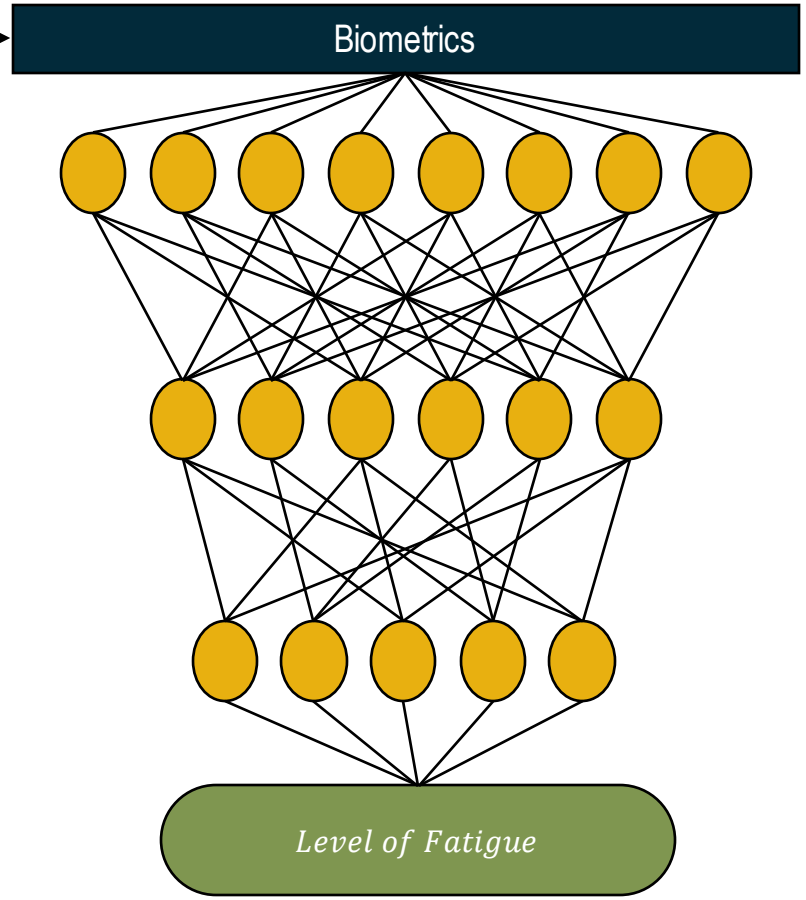
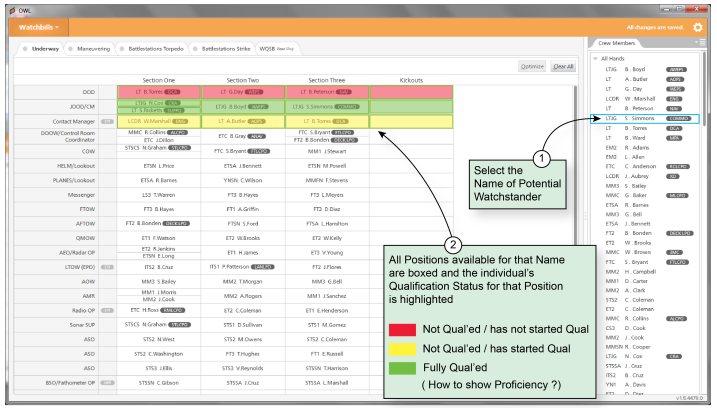


Image Sources: Microsoft Copilot, Wikimedia Commons

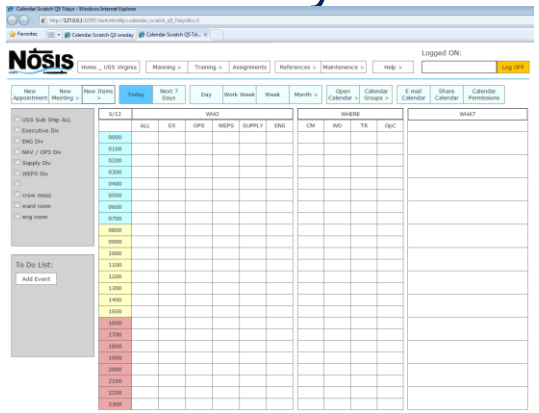
Watchstanding Management

- For Watchstanding Management, NSMRL partnered with Pulsar Informatics to develop the Optimized Watchstanding and Logistics (OWL) Tool

Watchbill



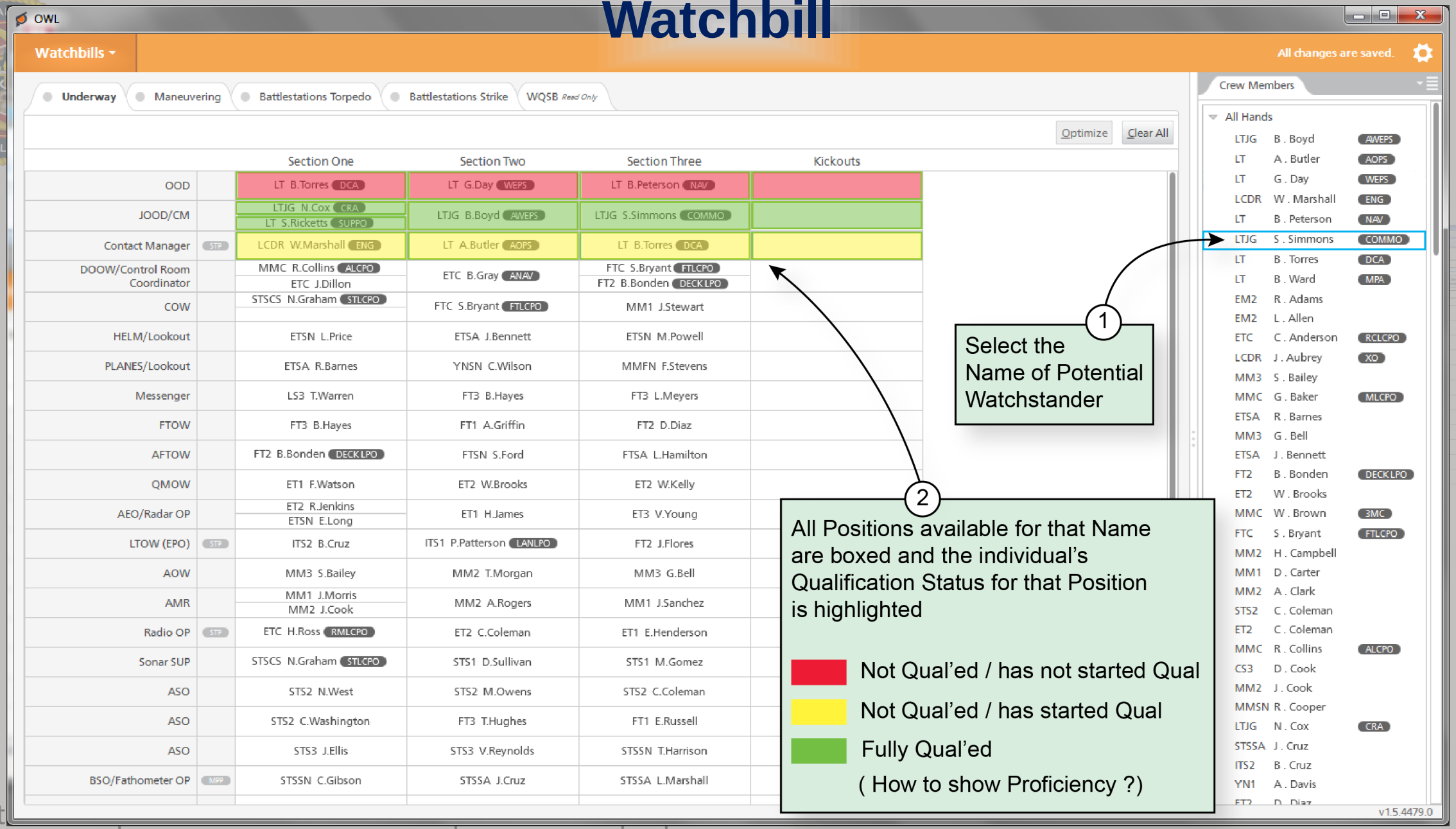
Plan of Day/Week



Fatigue Monitor

All tactical data presented is fabricated for presentation purposes

Watchbill

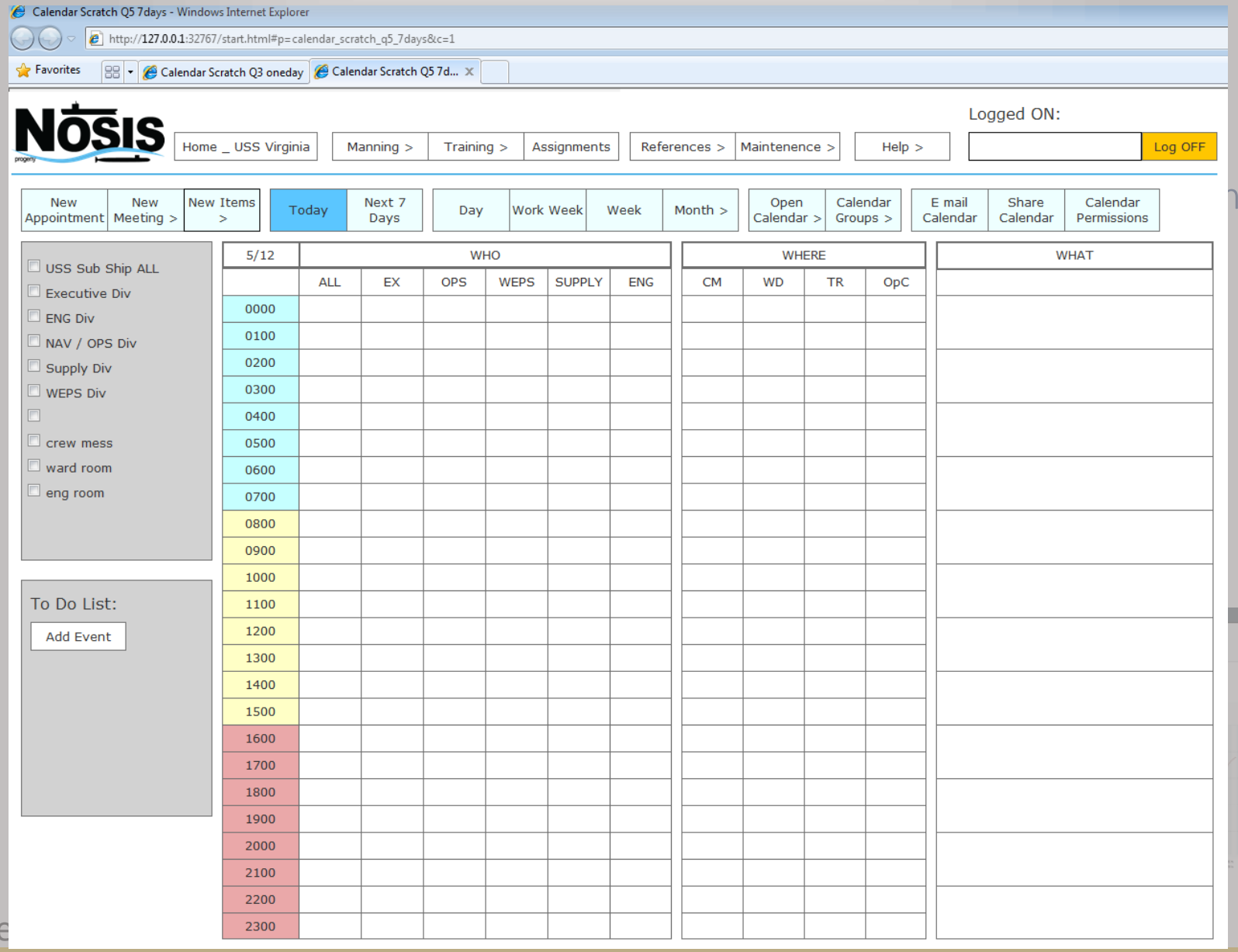


		Section One	Section Two	Section Three	Kickouts
OOD		LT B.Torres DCA	LT G.Day WEPS	LT B.Peterson NAV	
JOOD/CM		LTJG N.Cox CRA LT S.Ricketts SUPPO	LTJG B.Boyd AWEPS	LTJG S.Simmons COMMO	
Contact Manager	STP	LCDR W.Marshall ENG	LT A.Butler AOPS	LT B.Torres DCA	
DOOW/Control Room Coordinator		MMC R.Collins ALCPO ETC J.Dillon	ETC B.Gray ANAV	FTC S.Bryant FTLCPO FT2 B.Bonden DECK LPO	
COW		STSCS N.Graham STLCPO	FTC S.Bryant FTLCPO	MM1 J.Stewart	
HELM/Lookout		ETSN L.Price	ETSA J.Bennett	ETSN M.Powell	
PLANES/Lookout		ETSA R.Barnes	YNSN C.Wilson	MMFN F.Stevens	
Messenger		LS3 T.Warren	FT3 B.Hayes	FT3 L.Meyers	
FTOW		FT3 B.Hayes	FT1 A.Griffin	FT2 D.Diaz	
AFTOW		FT2 B.Bonden DECK LPO	FTSN S.Ford	FTSA L.Hamilton	
QMOW		ET1 F.Watson	ET2 W.Brooks	ET2 W.Kelly	
AEO/Radar OP		ET2 R.Jenkins ETSN E.Long	ET1 H.James	ET3 V.Young	
LTOW (EPO)	STP	ITS2 B.Cruz	ITS1 P.Patterson LANLPO	FT2 J.Flores	
AOW		MM3 S.Bailey	MM2 T.Morgan	MM3 G.Bell	
AMR		MM1 J.Morris MM2 J.Cook	MM2 A.Rogers	MM1 J.Sanchez	
Radio OP	STP	ETC H.Ross RMLCPO	ET2 C.Coleman	ET1 E.Henderson	
Sonar SUP		STSCS N.Graham STLCPO	STS1 D.Sullivan	STS1 M.Gomez	
ASO		STS2 N.West	STS2 M.Owens	STS2 C.Coleman	
ASO		STS2 C.Washington	FT3 T.Hughes	FT1 E.Russell	
ASO		STS3 J.Ellis	STS3 V.Reynolds	STSSN T.Harrison	
BSO/Fathometer OP	MPP	STSSN C.Gibson	STSSA J.Cruz	STSSA L.Marshall	

LTJG	B . Boyd	AWEPS
LT	A . Butler	AOPS
LT	G . Day	WEPS
LCDR	W . Marshall	ENG
LT	B . Peterson	NAV
LTJG	S . Simmons	COMMO
LT	B . Torres	DCA
LT	B . Ward	MPA
EM2	R . Adams	
EM2	L . Allen	
ETC	C . Anderson	RCLCPO
LCDR	J . Aubrey	XO
MM3	S . Bailey	
MMC	G . Baker	MLCPO
ETSA	R . Barnes	
MM3	G . Bell	
ETSA	J . Bennett	
FT2	B . Bonden	DECK LPO
ET2	W . Brooks	
MMC	W . Brown	3MC
FTC	S . Bryant	FTLCPO
MM2	H . Campbell	
MM1	D . Carter	
MM2	A . Clark	
STS2	C . Coleman	
ET2	C . Coleman	
MMC	R . Collins	ALCPO
CS3	D . Cook	
MM2	J . Cook	
MMSN	R . Cooper	
LTJG	N . Cox	CRA
STSSA	J . Cruz	
ITS2	B . Cruz	
YN1	A . Davis	
FT2	D . Diaz	

All tact

Plan of the Day / Plan of the Week



n of Day/Week

All tactical data presente

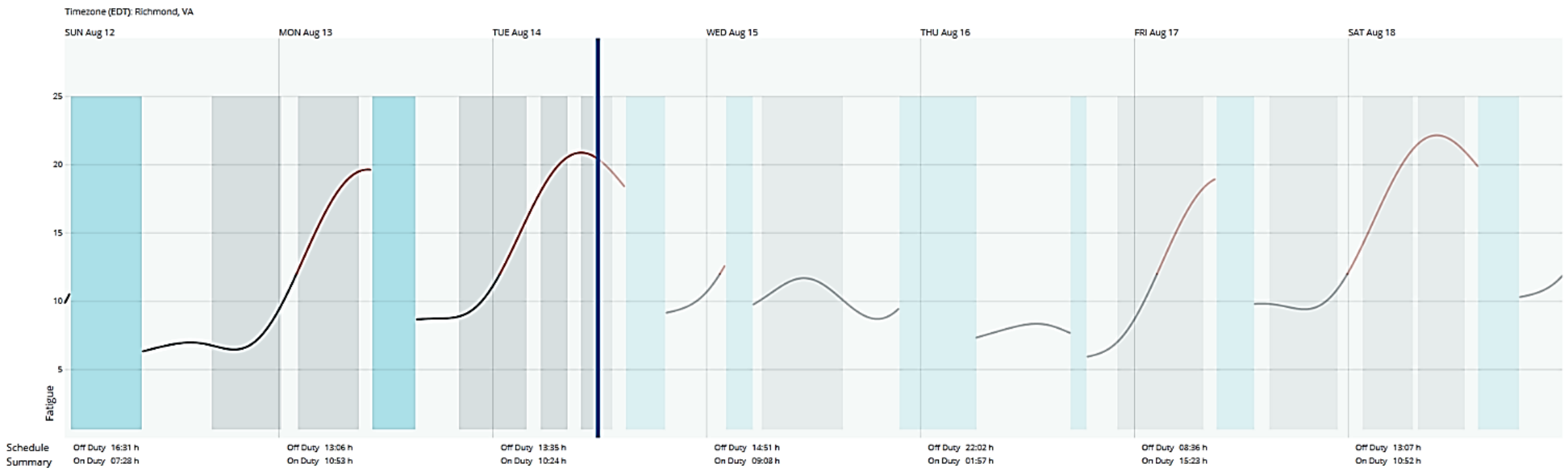
Fatigue Monitor

Dashboard | Team Insight

DACQ9695 — Quinn Dach
Supply
Fatigue Threshold: 12
View Report

Duty Events	Avg. Sleep	Avg. Fatigue	Peak Fatigue
10	5:37	13	22

Days | Timeline | Aug 12 - Aug 18 | ◄ Today ►



	SUN Aug 12	MON Aug 13	TUE Aug 14	WED Aug 15	THU Aug 16	FRI Aug 17	SAT Aug 18
Schedule Summary	Off Duty 16:31 h On Duty 07:28 h	Off Duty 13:06 h On Duty 10:53 h	Off Duty 13:35 h On Duty 10:24 h	Off Duty 14:51 h On Duty 09:08 h	Off Duty 22:02 h On Duty 01:57 h	Off Duty 08:36 h On Duty 15:23 h	Off Duty 13:07 h On Duty 10:52 h
Avg. Fatigue	7	13	17	11	7	11	19
Peak Fatigue	9	19	20	11	8	18	22

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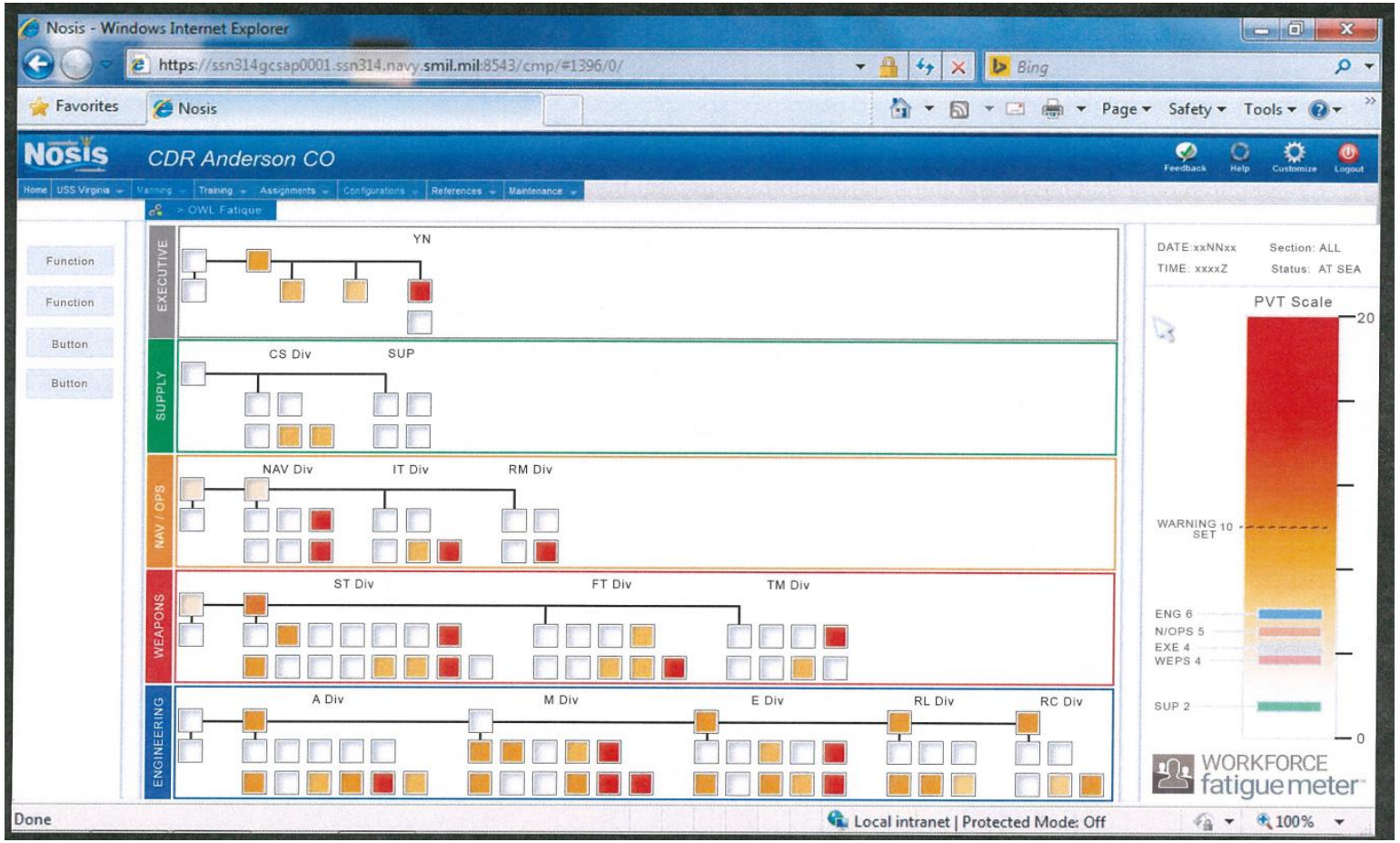
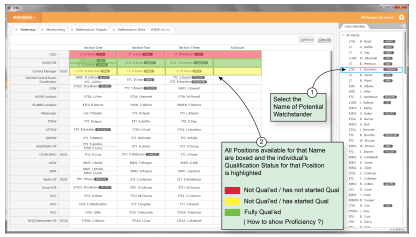
Watchstanding Management



Watchbill



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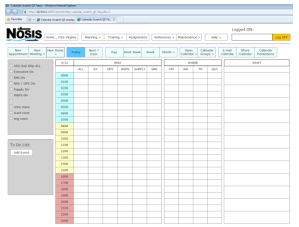
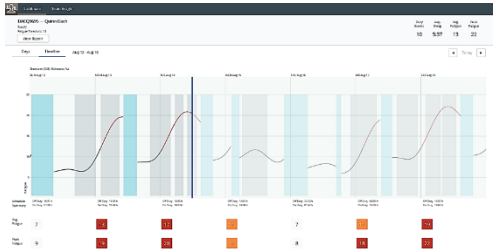


Fatigue Monitor



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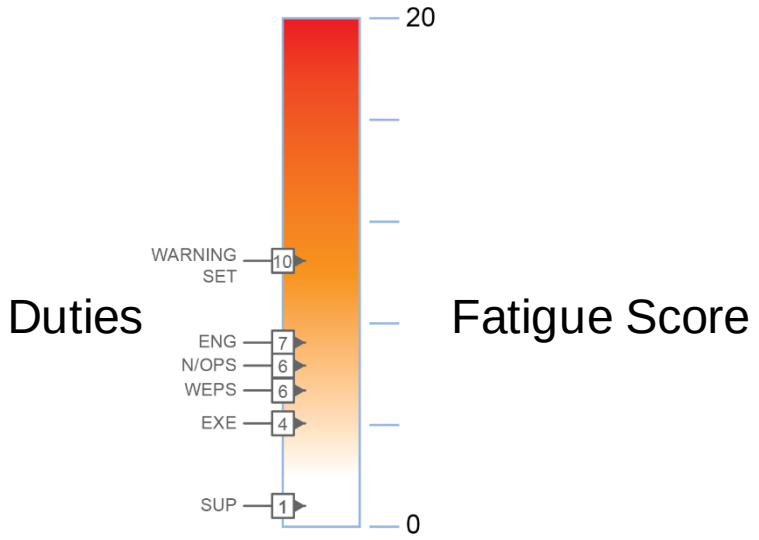
Future Research

- Machine Learning can use non-invasive monitoring to predict performance
- Future steps:
  - Develop larger data set with more operational predictions
  - Align fatigue scores to duties
  - Refine algorithms to update in real-time
  - Integrate wearables



Questions

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