A Transdisciplinary Approach to Maritime Transportation System Cybersecurity Education and Capability Development

Presented to NSA-CAE Conference

by Jeff Greer | Lecturer, Cybersecurity | @ UNCW
On Behalf of The Authors

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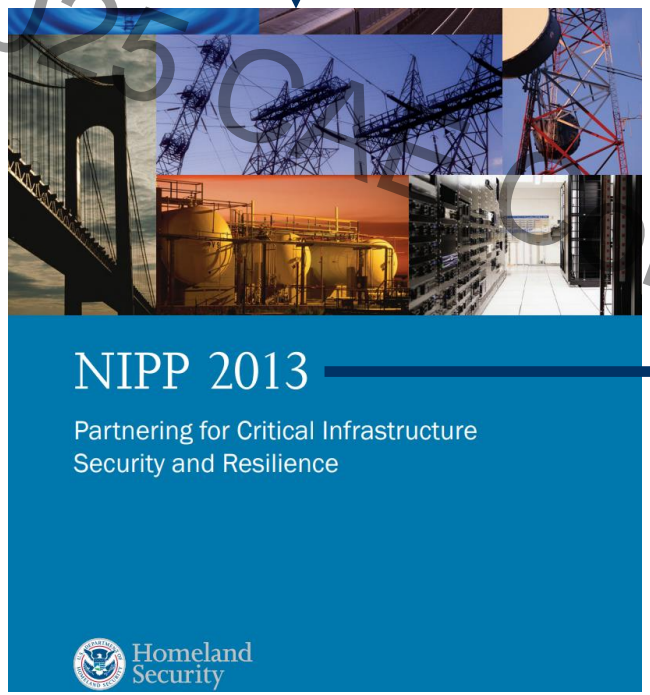
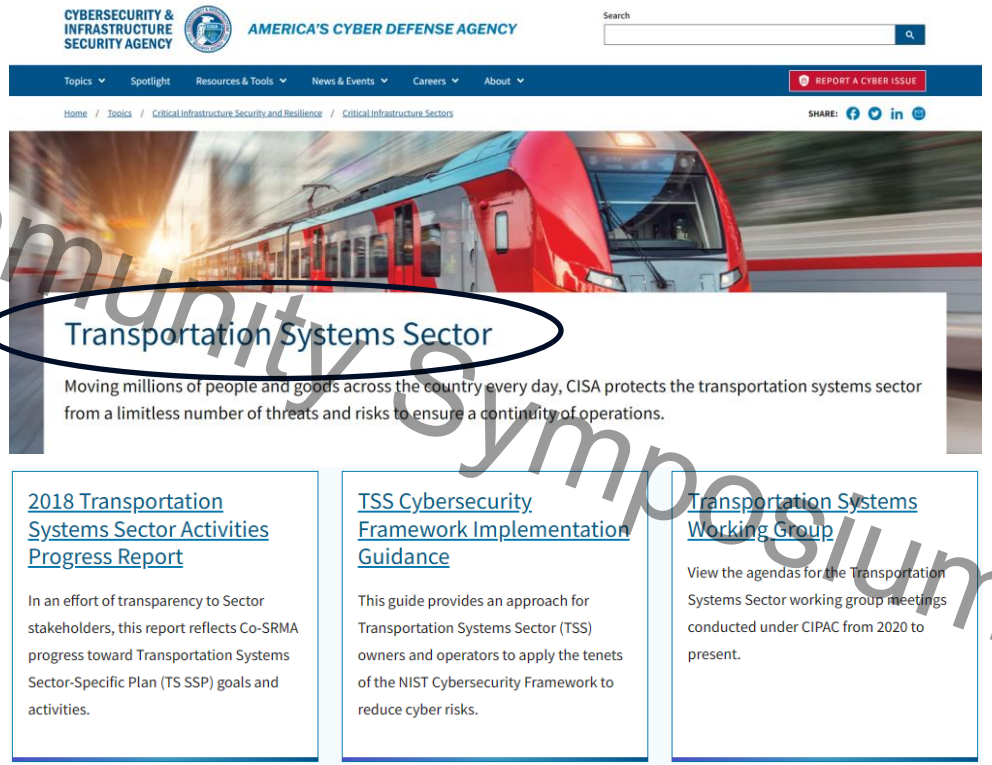
Background

Presidential Policy Directive (PPD) 21: Critical Infrastructure Security and Resilience



16 Sectors Identified



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Motivation – Two Questions That Merit Consideration

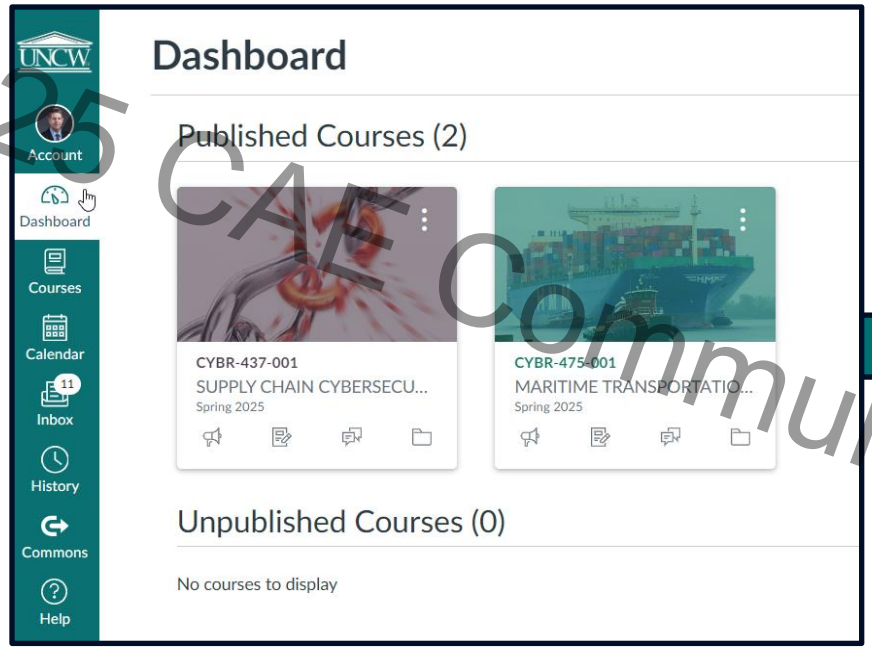
- What is the optimal applied cybersecurity training program for maritime and other critical infrastructure operators?
- What improvements can be made to accelerate student KSA development and advancement into leadership positions?

Teach Critical Thinking Skills

Reality – Technologies Come and Go over a Career …
Critical Thinking Skills Are Forever and Enable Effectiveness

5 Key Questions Students Need to Ask & Learn How to Answer	For a Named System of Interest (SOI)
1. What is it?	Ship (Stereotypical or named)
2. Why does it matter?	<Security Scope Determination>
3. How does it work	<Functional Modeling>
4. How can it fail	<Hazard Loss Analysis>
5. How can failure be managed?	<Strategic and Tactical Cyber Risk Management Strategy Design>

Canvas – UNCW's Learning Management System



Virtual Ship Training Environment

Jeff Greer
Kasey Miller

Physical Test Bench Training Environment

Hosam Alamleh
And Bilge Karabacak

Ulku Clark and Geoff Stoker
Program Development

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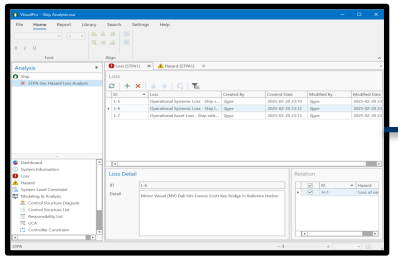
Virtual Ship Training Environment Overview

OSINT Consequence-Driven Hazard Loss Analysis



WVAY – STPA-Sec With STRIDE

OSINT Cyber-Informed Threat Intelligence

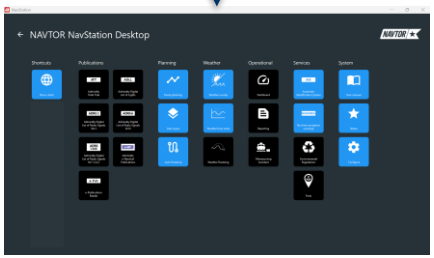
MCAD Cyber-Attack DB

Creative Guidance:

The DoD Cyber Tabletop Guide
NICE, The Cyber Range, A Guide
The 5 W's of Systemigrams

UNCW Maritime LMS Library

Address Targeted Educational Needs



NAVTOR
Navigation Planning

Nautis (Cloud)
Bridge Simulator

Dr. Kluj @ Unitest
Engine Simulator

INL M-DAT
Incident Management

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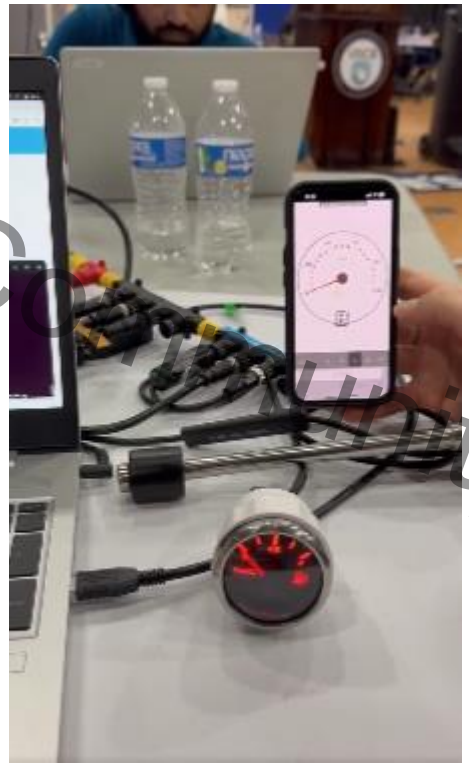
Test Bench Training Environment



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UNCW Maritime LMS Library Content

Educational

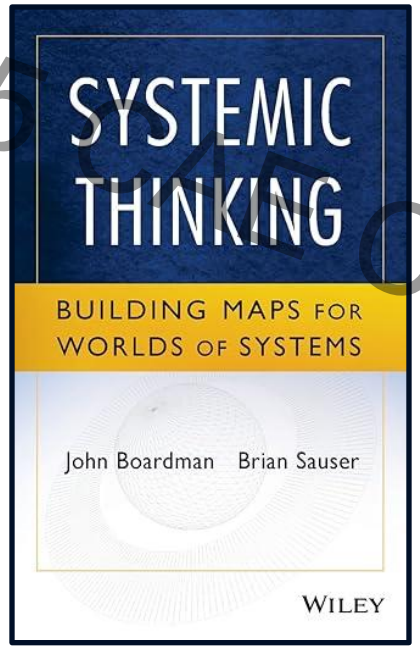
- Learning Objectives
- Lesson Plans
- Lab Plans
- Tabletop Exercises
- Assessment

Reference Materials

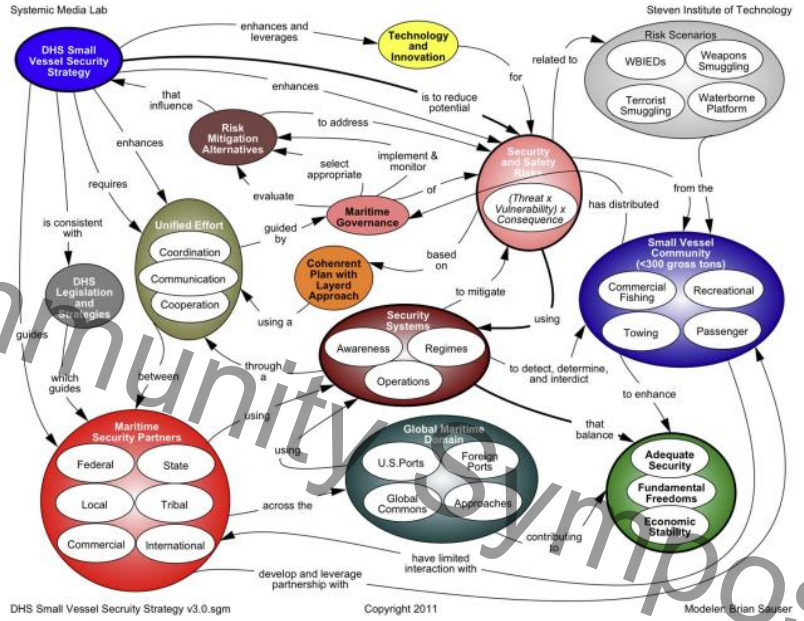
- Relevant OSINT Sources
  - Industry Awareness
  - Maritime Losses
  - Threat Intelligence
- Safety Regulations
- Technical Standards
- Free Online Training Resources

Note: It is the library that integrates all the single function simulators, specialized software programs, and content for education delivery!

Teach System Thinking Skills



Design Tools



Source: Systemigram Modeling of the Small Vessel Security Strategy for Developing Enterprise Resilience

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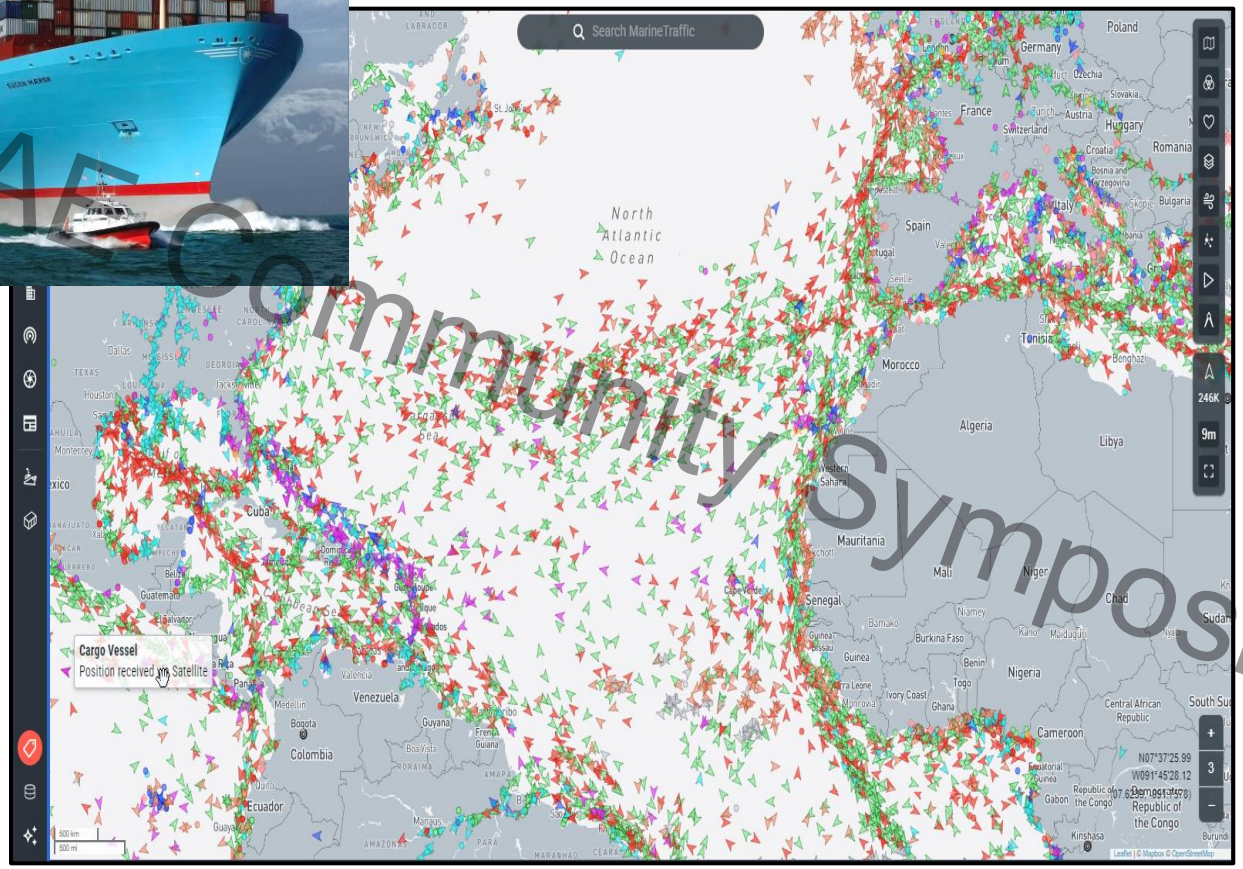
Maritime Industry Knowledge



MarineTraffic.com

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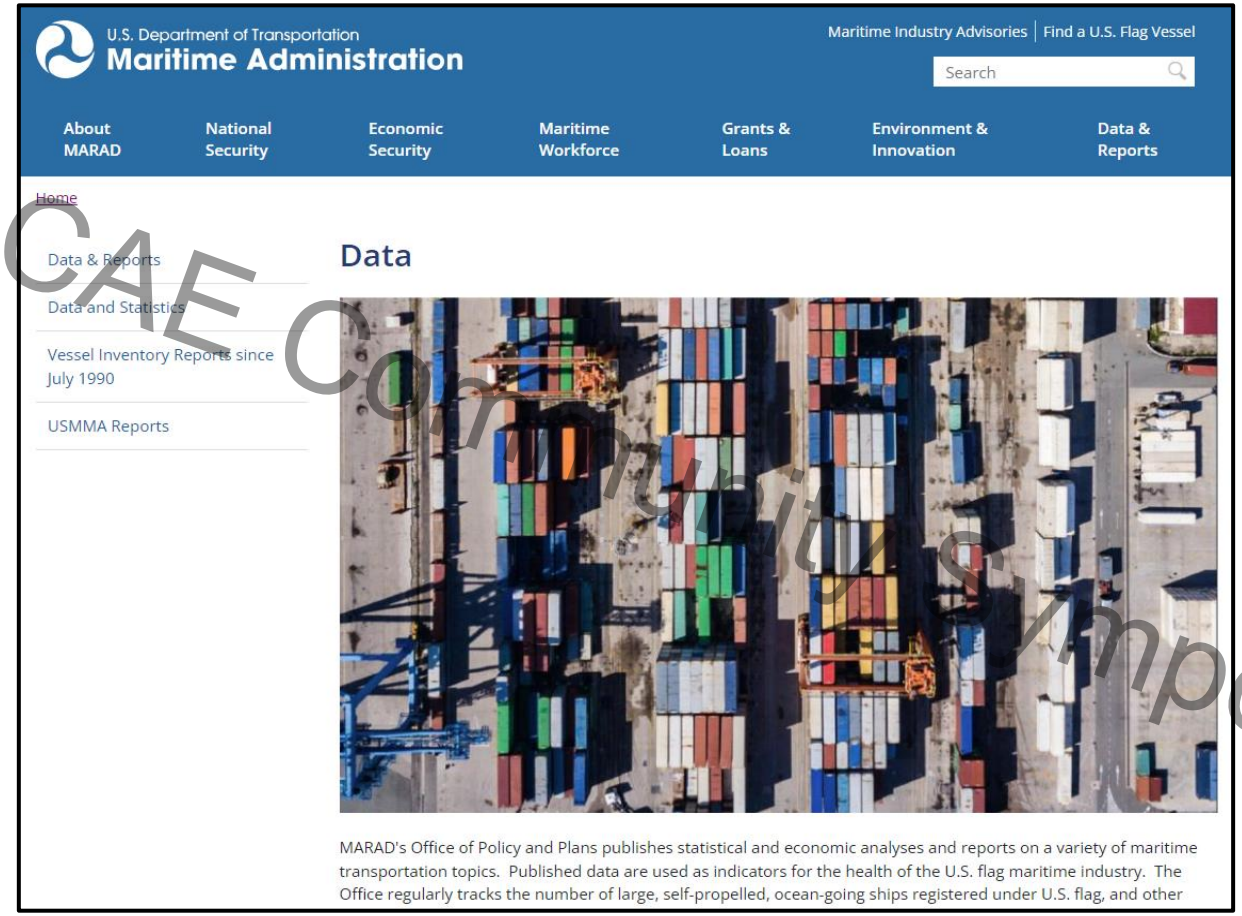
Maritime Commercial Knowledge



DOT (MARAD) Shipping Statistics

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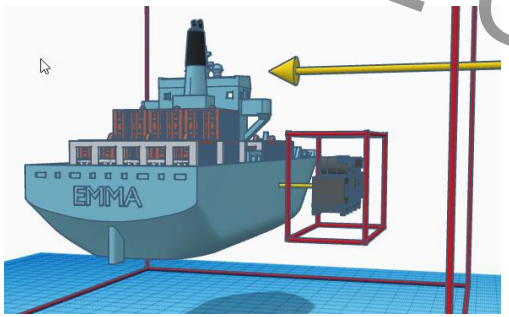
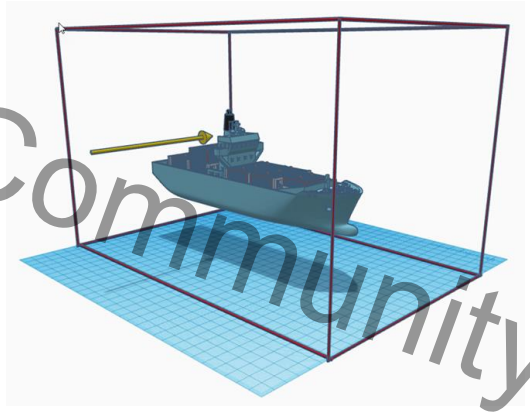
Teach System Engineering Skills

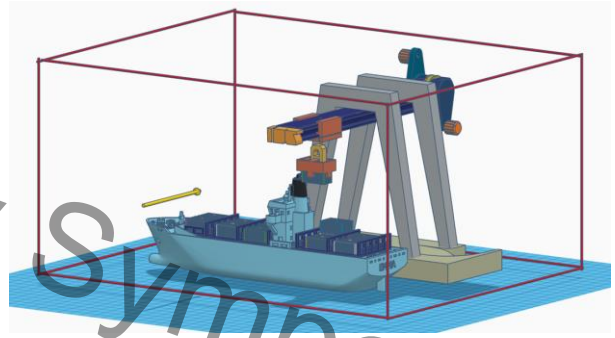
Security Domain Boundary Modeling – iBox Method Developed @ UNCW



Sub-Domain – Engine Room



SOI Security Domain Boundary



Super Domain – Ship + Port

Models Developed in TinkerCad
With Thinglverse.com 3D Models

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Source John Boardman and Edward Bowers

Manage the Convergence of Multiple Critical Systems Within a Single System of Interest Security Domain

Critical System Types	Utilized Digital Technologies	Security Objectives
Informational	IT	CIA
Operational	OT, IoT, CPS	Safety
Military	Sensors and Kinetic Weapons	Mission Achievement

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Network Segmentation and Integration Point Management Design

Maritime Domain Specific Technical Knowledge

Abstracted Functional Ship Control Model

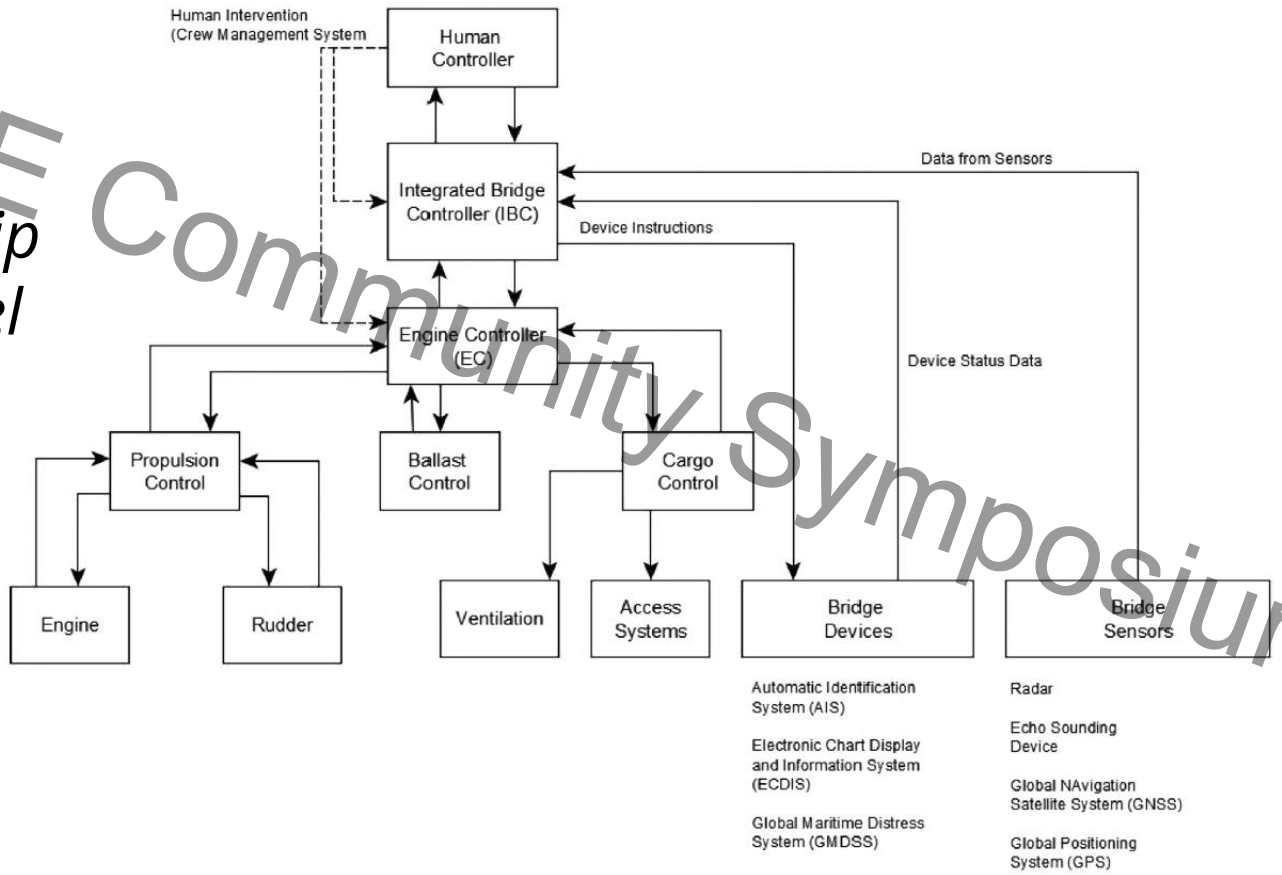

Fig. 1. CyberShip framework.

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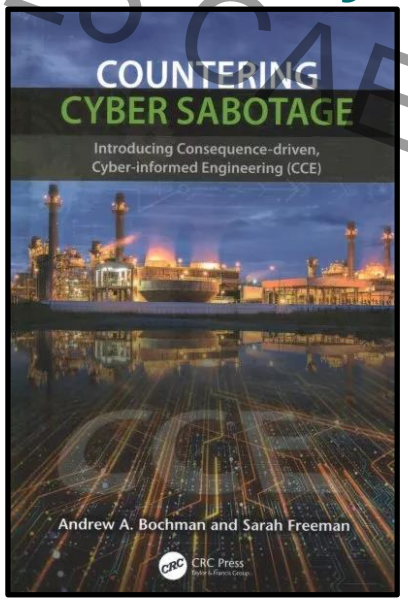
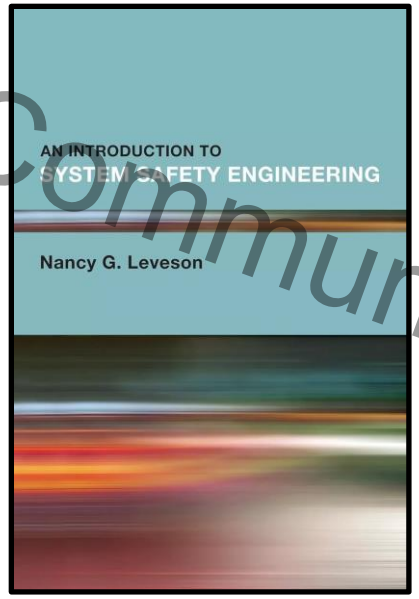
Teach Safety Engineering Skills

INL Theory



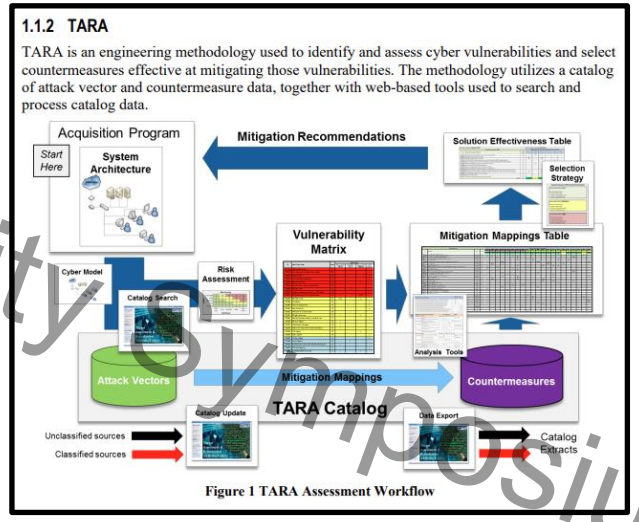
INL CCE Website

MIT Theory



MIT PSASS Website

MITRE Theory



MITRE TARA Website

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Why Safety Matters

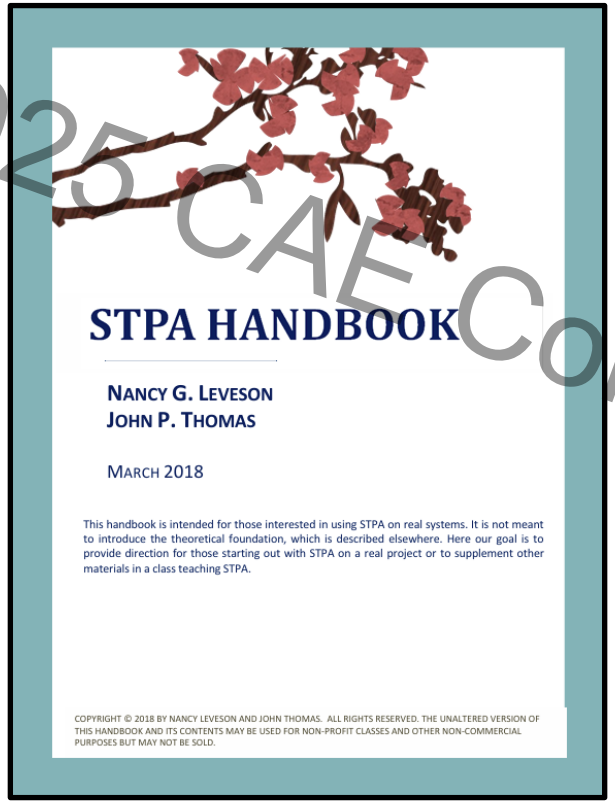
- Design goal – a secure digital operating environment free from fault
- Alternatively, one that fails safe and recovers quickly

Start Here → Work Left to Right →

Direct and Consequential Losses to Avoid	ID Hazards Triggered by a Cyber-Attack	Conduct a Hazard Risk Analysis	Select Appropriate Risk Treatments

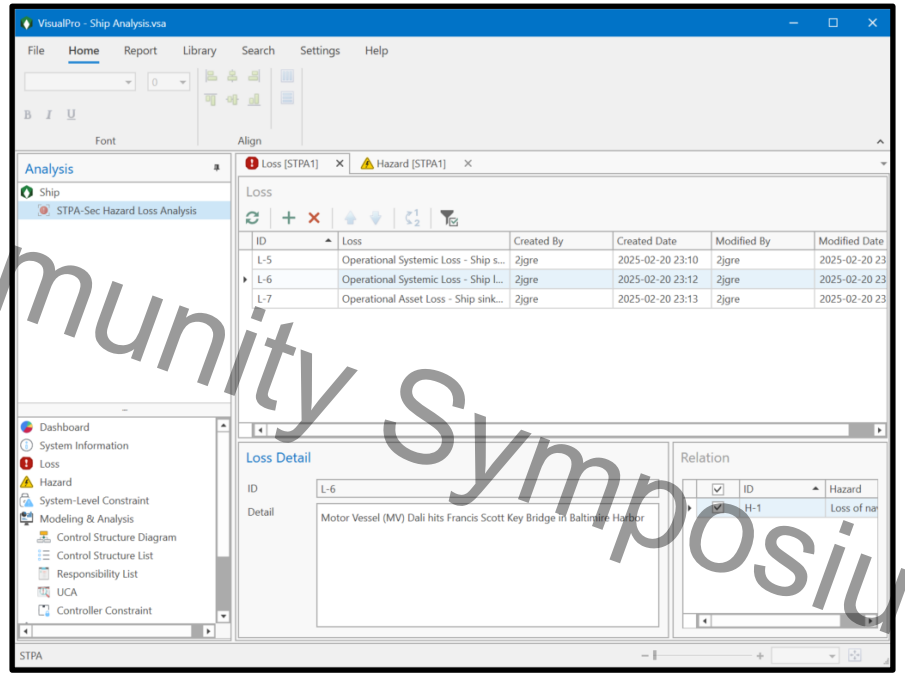
Note: The spectrum of risk treatments now includes classic security controls, dynamic countermeasures, and resilient digital infrastructure design.

Utilize Hazard Loss Analysis Tools



MIT PSASS Website

VWAY - VisualPro



Hazard Loss Analysis Application

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Teach Cybersecurity Engineering Skills

- **SbG – Security by Governance**
  - Design an effective cybersecurity program enabling security goal and objective achievement
- **SbD – Security by Design**
  - Design a secure digital operating environment
- **SbO – Security by Observation**
  - Design a monitoring capability to assure the digital operating environment design is secure
- **SbR – Security by Response**
  - Design a cyber incident response capability to contain and remediate a discovered cyber-attack
- **SbA – Security by Assessment**
  - Design an assessment methodology for adaptive learning and continuous improvement over time

Near Term – Tool Enable Next Gen Cyber Defenders to Counter Adversarial AI

Novel Engineering Workstation Design

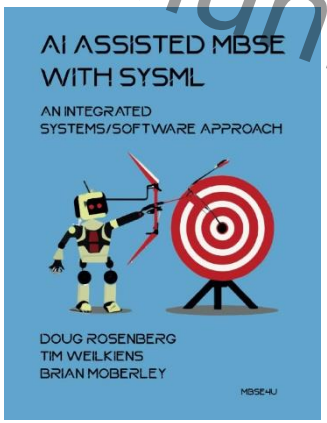
Improve Decision Making Speed and Effectiveness!

Proof of Concept in Development @ UNCW

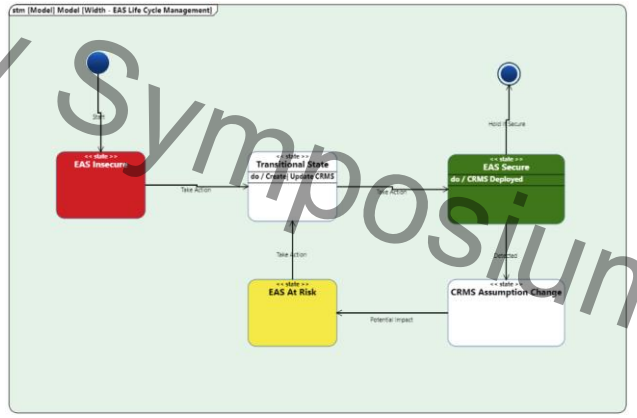
for Student - Senior Cyber Risk Manager Use

Enterprise Attack Surface Model

Digital Twin - Persistent Real Time Data Fabric For Design Use



Cyber Risk Mgmt. Strategy Design and Deployment



State Machine Approach for Managing the Enterprise Attack Surface

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Questions and Comments

Constructive Feedback Is Appreciated!

Contact: greerj@uncw.edu

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