



VCU



Managing Port Safety and Security Risk Using Dynamic Simulation

Jason R. W. Merrick

Virginia Commonwealth University

Jack Harrald, J. Rene van Dorp

The George Washington University

Thesis Statement

- Risk interventions are the tool for making ports safer.
 - Historically aimed at oil spills.
 - Later efforts aimed at passenger safety.
 - Now we must turn our efforts to security.
- Risk management must be sustainable
 - Ensuring the ongoing economic viability of a port or waterway
- Port must be considered as a system

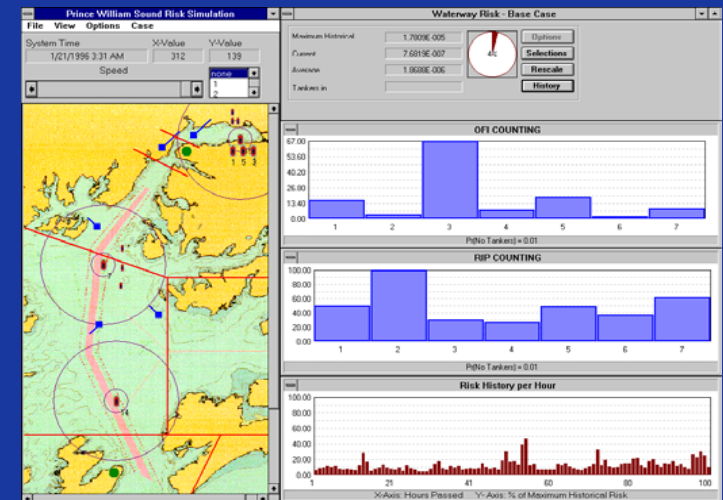
Research in a Nutshell

- “One of the ironies of globalization is that, besides being a potential motivation of attacking America, growing global trade may also provide the delivery mechanism for a devastating attack on the U.S.” [USCG Commandant James Loy (retired)]
- Research objectives:
 - Enable decision-makers to manage security and safety in an economically sustainable manner
 - Simulation models show systemic effects of proposed interventions
 - In a data-sparse environment, eliciting the knowledge of experts is critical to meaningful decision making

Previous Work



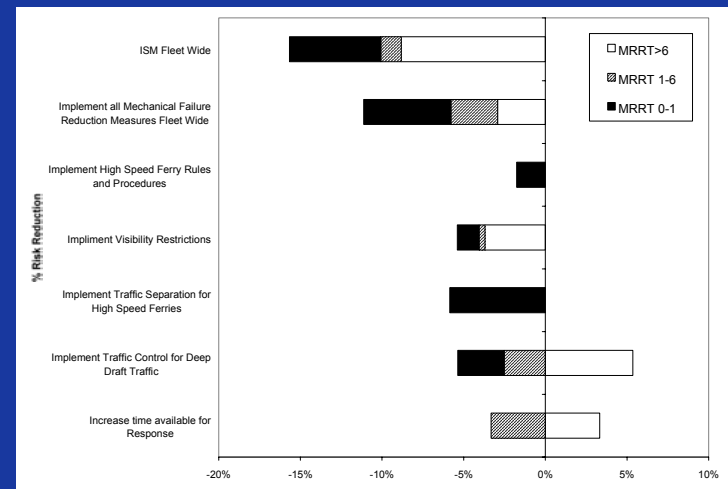
- Prince William Sound Risk Assessment
 - Site of the Exxon Valdez Disaster
 - Model used system simulation, data analysis and expert judgment
 - Capable of modeling systemic effects of proposed interventions
 - Multi-million dollar investments made to reduce risk of further oil spills



Previous Work

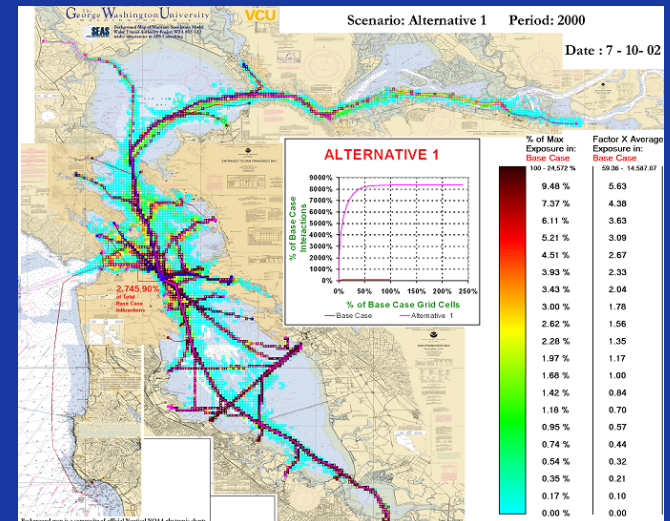
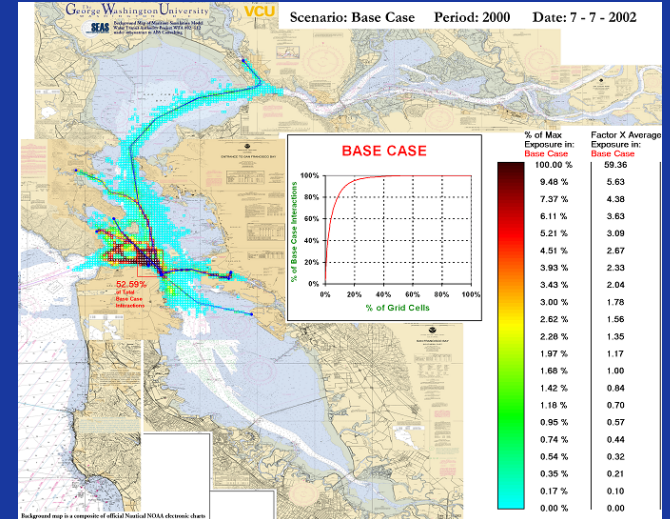


- Washington State Ferries Risk Assessment
 - Largest ferry system in the United States
 - Simulation/expert judgment model improved based on NRC review of PWS study
 - Legislature approved funding of Safety Management System, training and emergency preparedness exercises



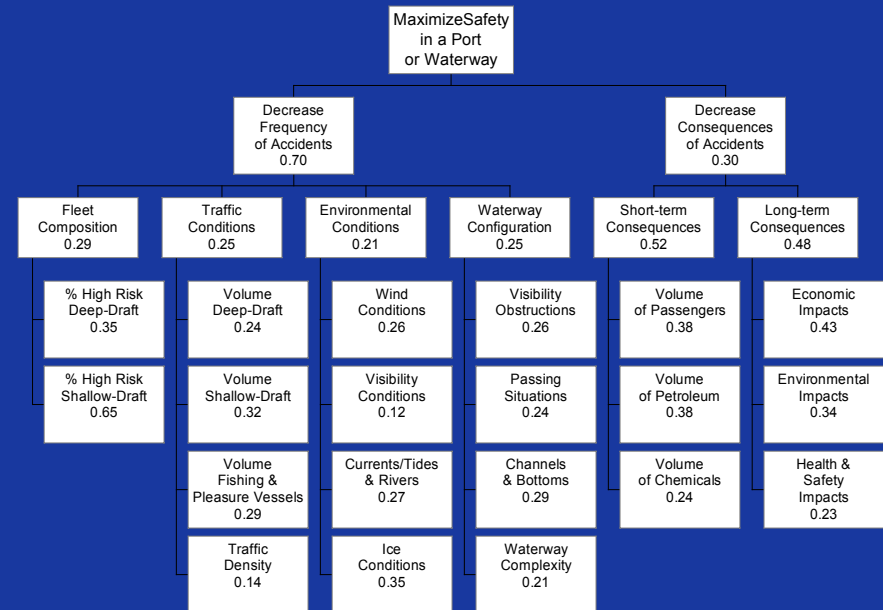
Previous Work

- San Francisco Bay Exposure Assessment
 - California legislature examining the effects of major expansion of ferry services
 - Simulation model tested the impact of proposed expansion on vessel interactions
 - Legislature considering implementing proposed expansions

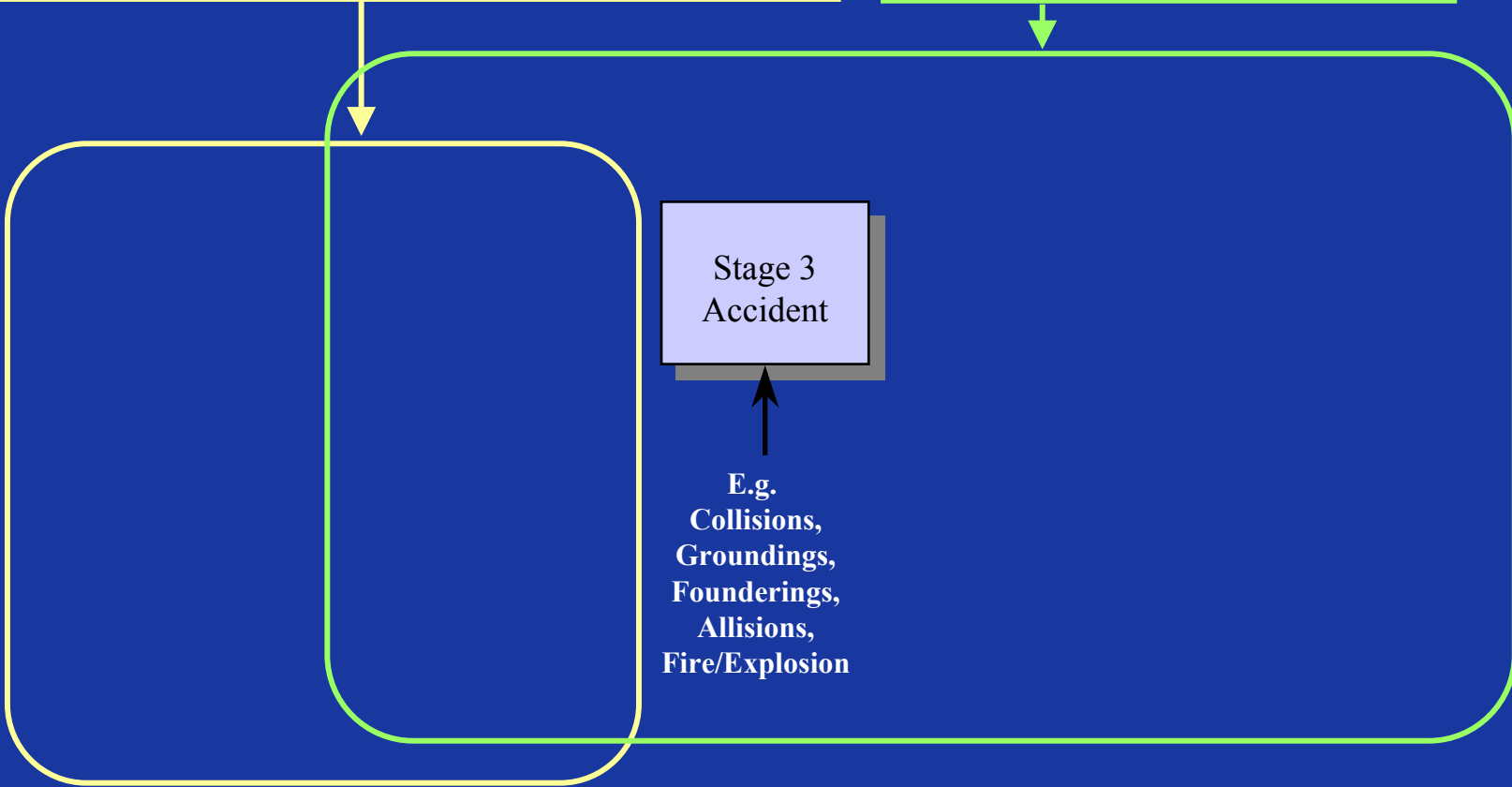
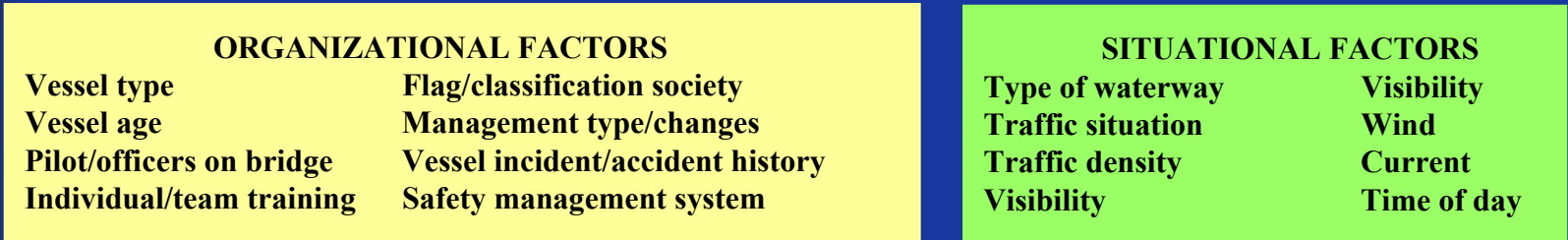


Previous Work

- Ports and Waterways Safety Assessment
 - Federal decisions require examination of numerous ports
 - Multi-attribute model created from expert and stakeholder sessions
 - Model used in resource allocation for new vessel traffic management technology



Accident Event Chain



Accident Event Chain

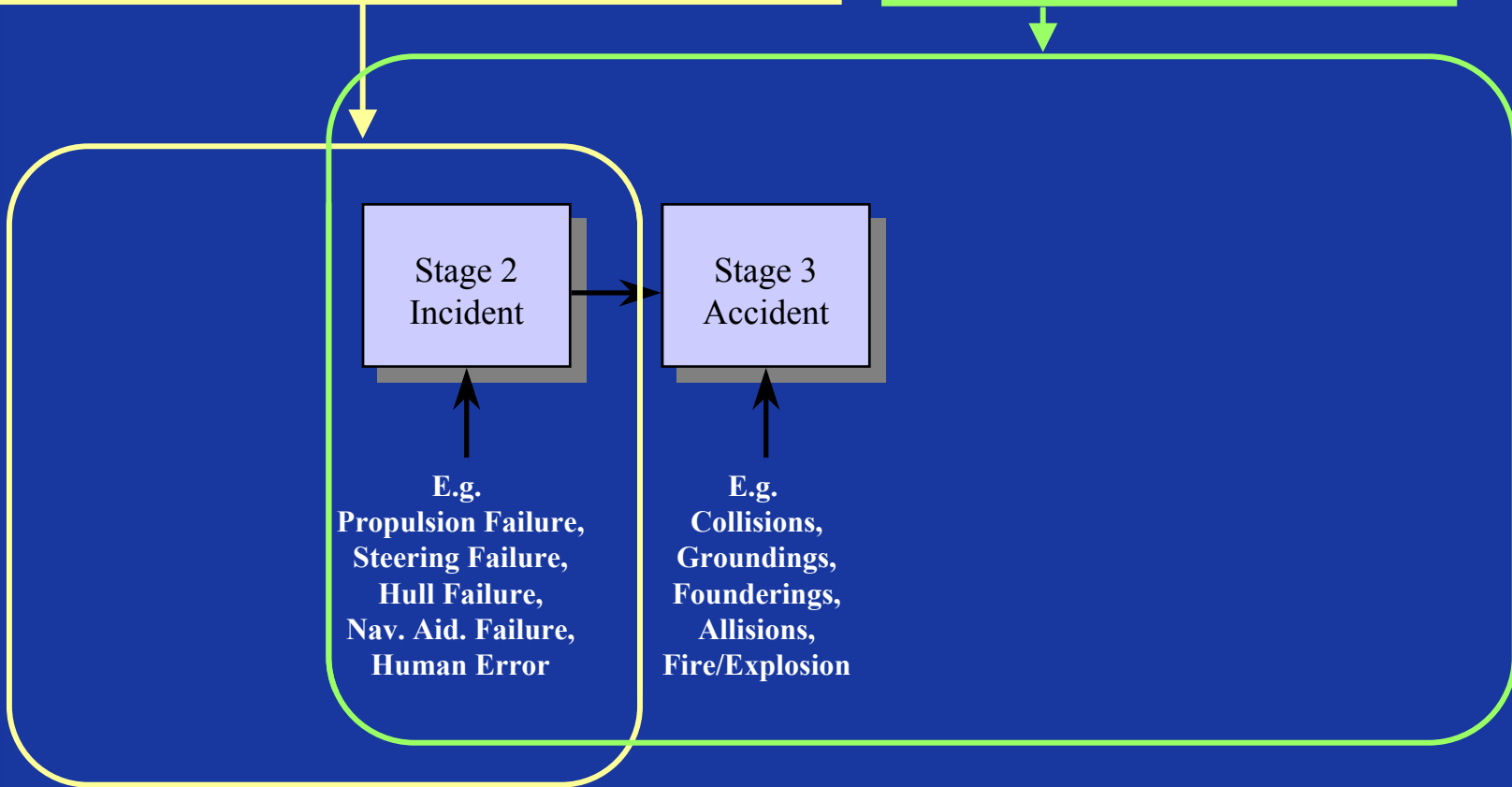


ORGANIZATIONAL FACTORS

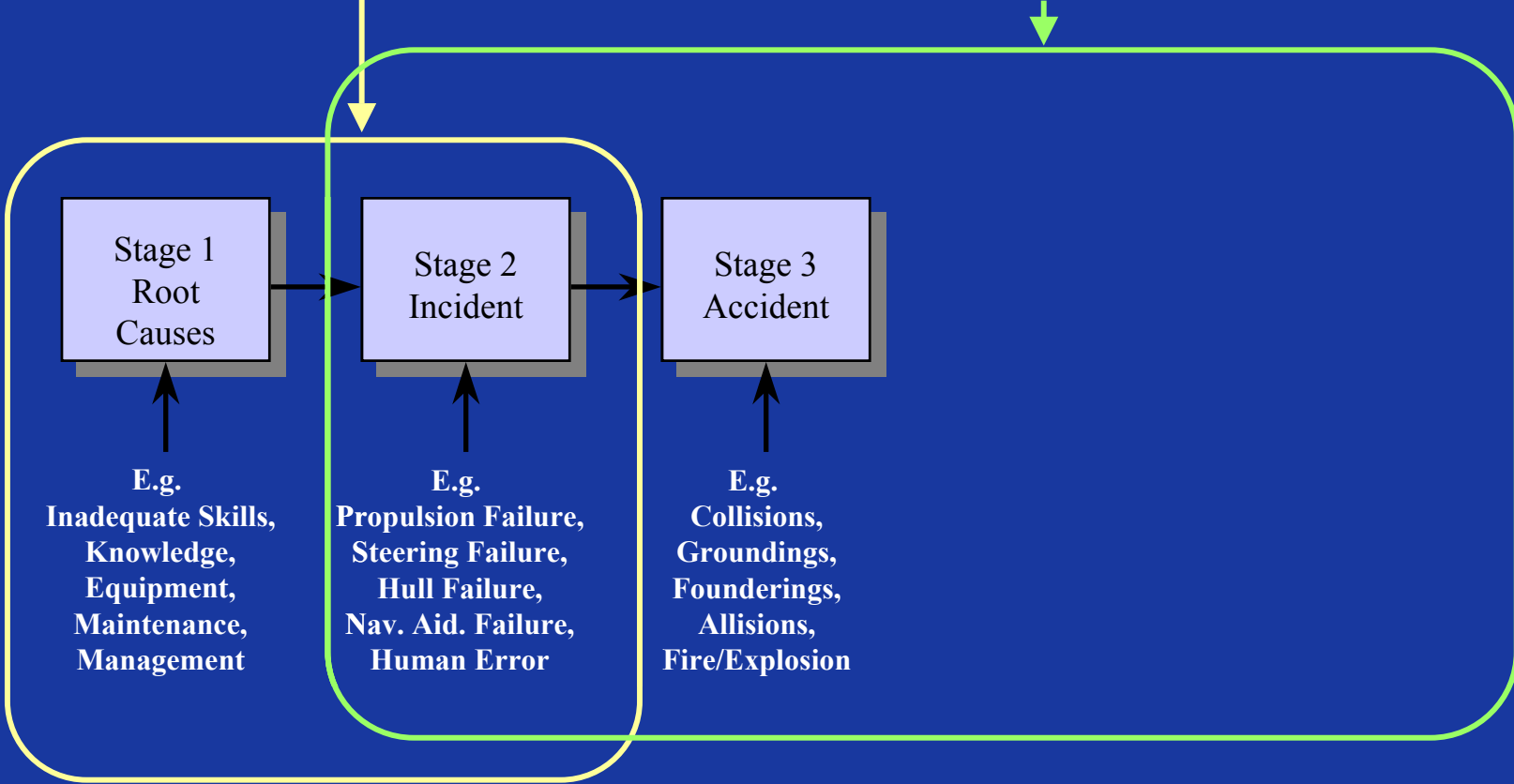
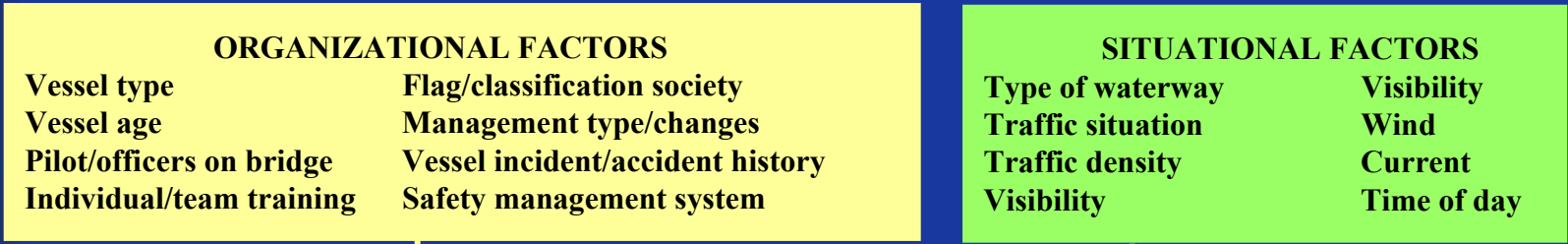
Vessel type	Flag/classification society
Vessel age	Management type/changes
Pilot/officers on bridge	Vessel incident/accident history
Individual/team training	Safety management system

SITUATIONAL FACTORS

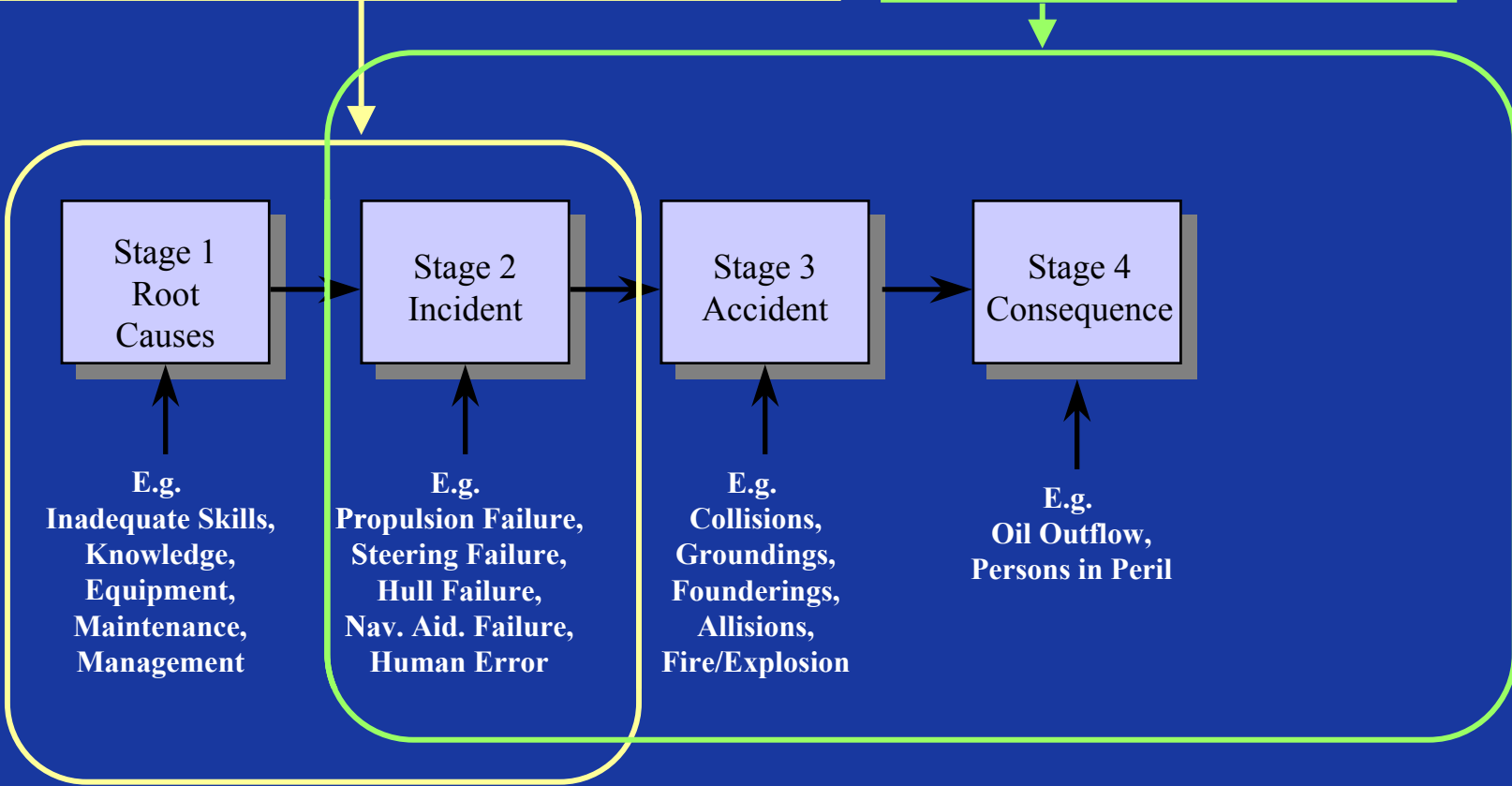
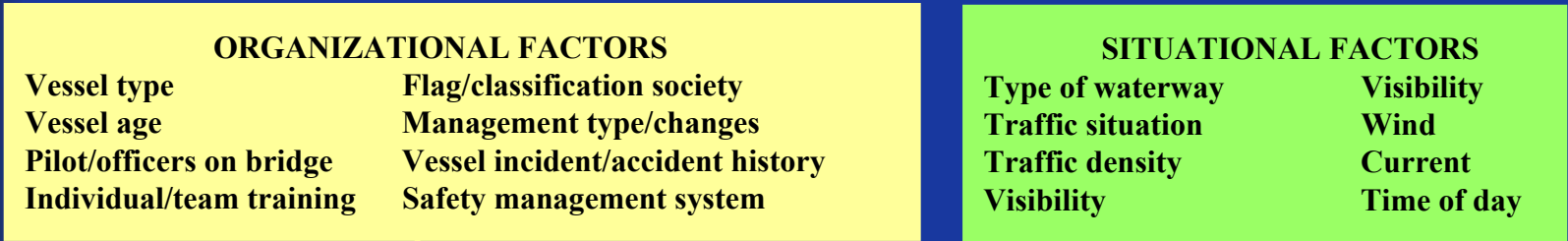
Type of waterway	Visibility
Traffic situation	Wind
Traffic density	Current
Visibility	Time of day



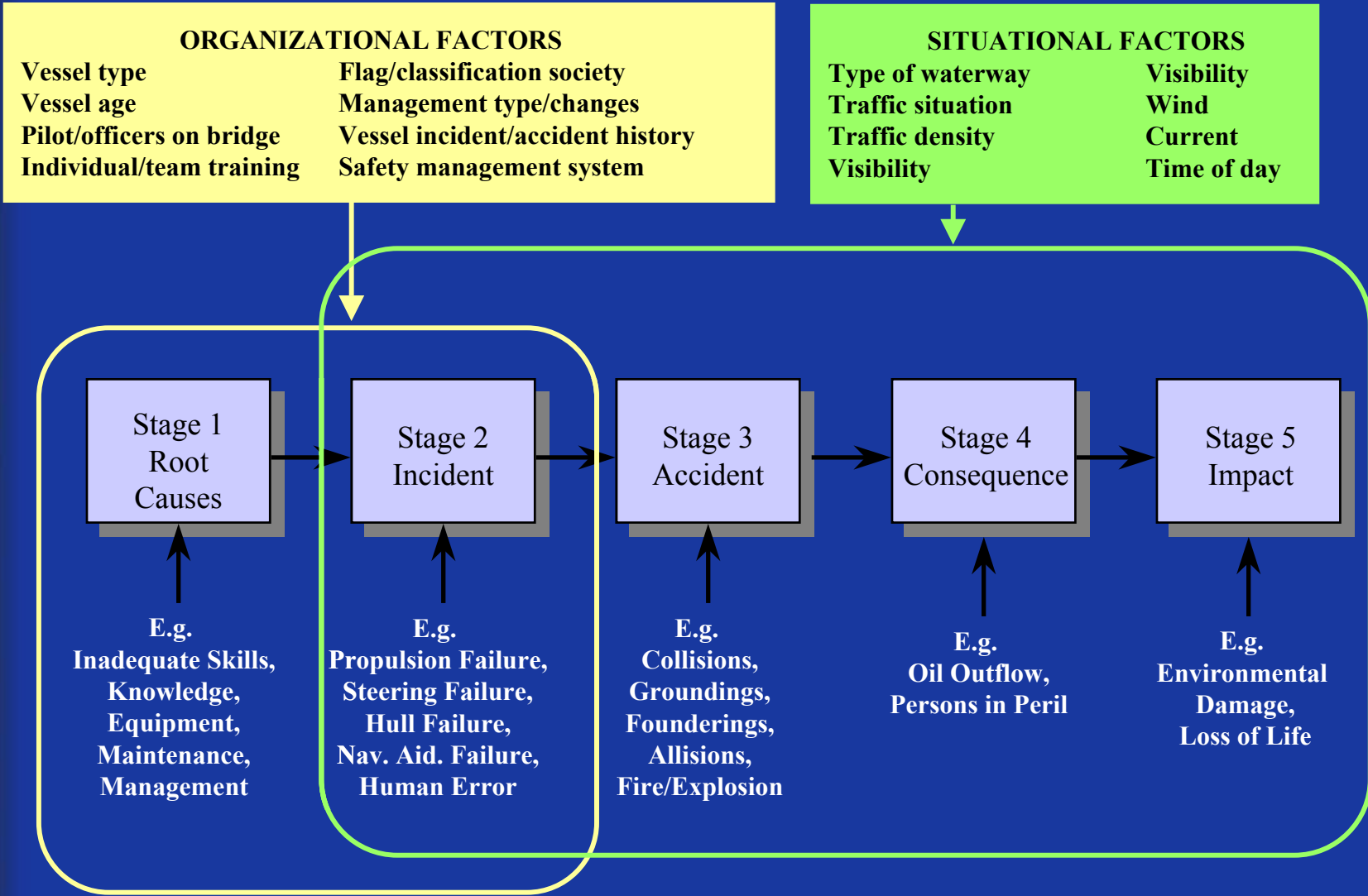
Accident Event Chain



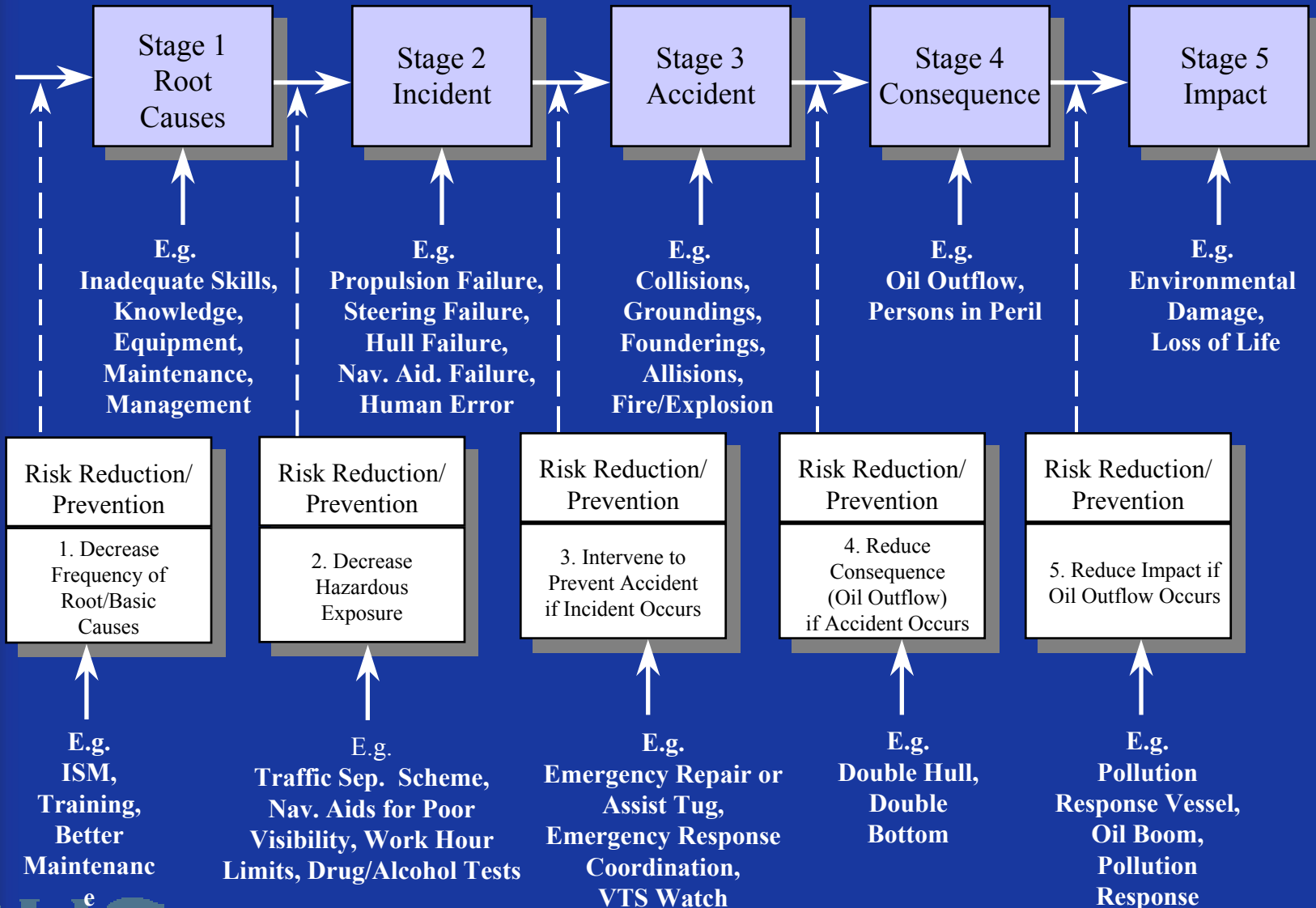
Accident Event Chain



Accident Event Chain



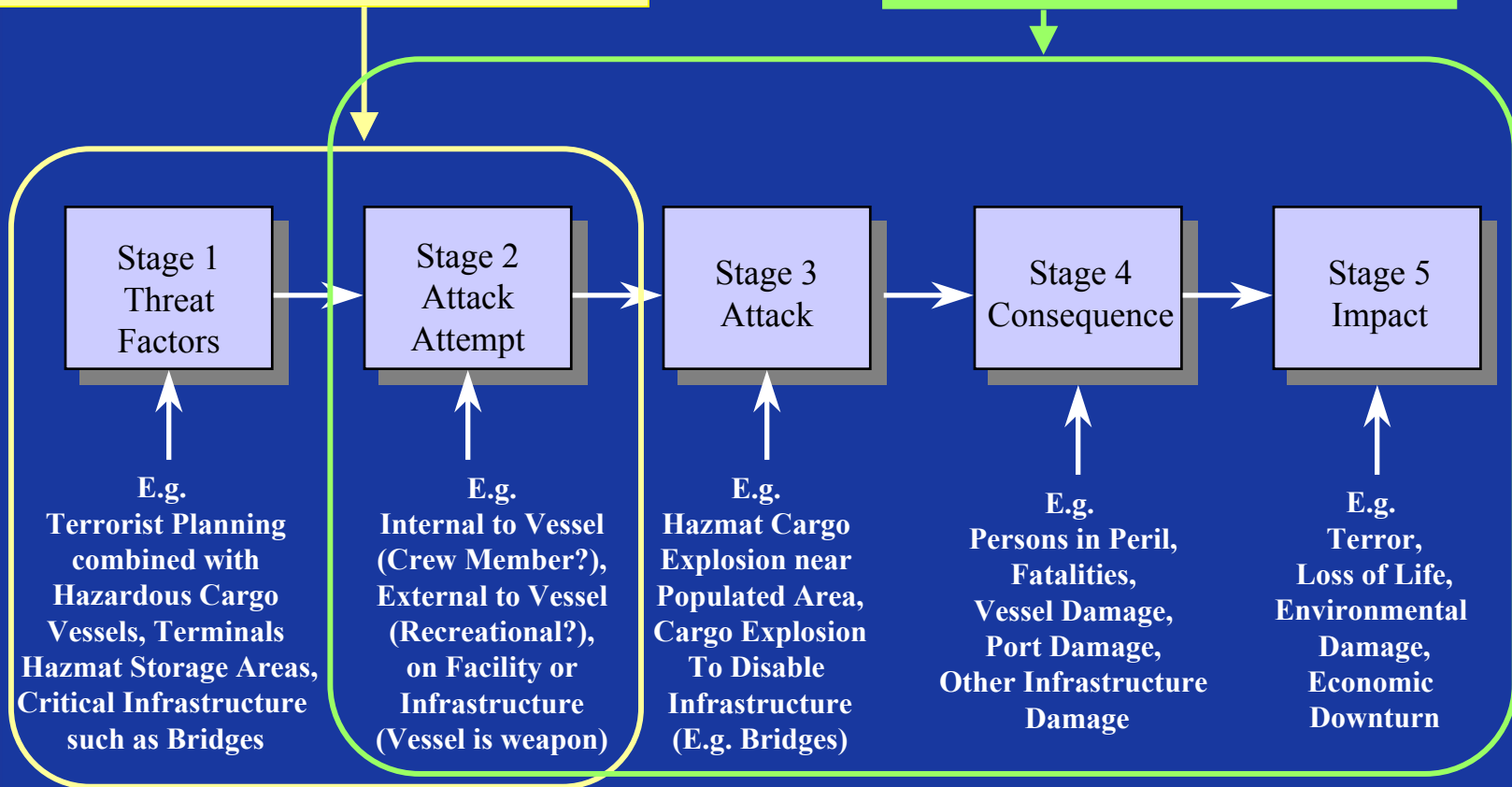
Accident Interventions



Attack Event Chain

ORGANIZATIONAL SUB SYSTEM FACTORS
 Two Markets, Industrial Trade of Vessels, Owned Chartered by Oil Companies, spot market trade vessels, Tankers often escorted, Maritime Routes Not Designed with Security in Mind

SITUATIONAL FACTORS
 Closeness of Explosion to Population Area, Chemical Facilities or Infrastructure (e.g. Port Assets, Bridges). Traffic Density, Time of Day, Weather Conditions



Attack Interventions

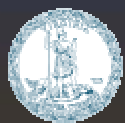
PETROCHEMICAL SUBSYSTEM: Interventions and Organizational Responsibilities

1. Reduce Threat Factors	2. Reduce Likelihood of Attack Attempt	3. Reduce Likelihood of Attack Success	4. Reduce Immediate Consequences	5. Reduce Delayed Consequences
<p>e.g.</p> <ul style="list-style-type: none"> • Disrupt Terrorist Activities • Identify Owner and Crew List, • Locate Chem. Plants away from population areas, • Trusted Vessels Program. 	<p>e.g.</p> <ul style="list-style-type: none"> • Arm Vessels, • Board Vessels at Port of Entry, • Improved Intelligence and Detection, • Escort Vessels 	<p>e.g.</p> <ul style="list-style-type: none"> • Escort Vessels, • Ship Riders, • Improve Terminal Security 	<p>e.g.</p> <ul style="list-style-type: none"> • On Board Fire Suppression, • Escort Vessel Fire, Rescue Response. • Facility Fire, Rescue and Pollution Resp. • Resp. Exercises 	<p>e.g.</p> <ul style="list-style-type: none"> • Pollution Response, • Mass Casualty Response. • Port Contingency Plans & Experience.

Organizational Responsibilities (indicated by green arrows):

- U.S. Coast Guard:** Stage 1 to Stage 5
- Oil Companies:** Stage 1 to Stage 5
- MARAD:** Stage 1
- Pilots:** Stage 1 to Stage 2
- DOD:** Stage 1
- VTS/VTIS:** Stage 2 to Stage 3
- Local Fire/Rescue:** Stage 3 to Stage 5
- State/Local Law Enf.:** Stage 2 to Stage 3
- EPA:** Stage 5
- TSA:** Stage 1 to Stage 3
- FEMA:** Stage 3 to Stage 5
- FBI:** Stage 1 to Stage 2
- CIA:** Stage 1 to Stage 2
- Acute Medical Care:** Stage 4 to Stage 5

EXAMPLES OF ORGANIZATIONAL RESPONSIBILITY FOR INTERVENTIONS



Modeling Approach

- Port Simulation
- Definition of Critical Infrastructure at Risk
- Exposure Counting Model
- Multi-attribute Security Vessel Risk Model
 - Owner/Operator, Type of charter, Cargo Broker, Officers/crew id, Nationality, Background, Crew agent, Flag State, Agent, Last Port, Voyage Route, Unique voyage or routine route, Loading Facility.

Benefit to Defense and Homeland Security

- Base model outputs:
 - Geographic Profile of Security Risk
 - Geographic Profile of Safety Risk
- Model proposed security interventions:
 - Systemic impact on security risk
 - Systemic impact on safety risk
 - Impact on efficiency and economics of port operations

Research Sponsors

- Prince William Sound Shipping Companies.
- Prince William Sound Regional Citizens' Advisory Council
- United States Coast Guard
- Washington State Ferries
- Washington State Transportation Commission
- San Francisco Bay Water Transit Authority
- National Science Foundation

See NSF Project Web-Site for Journal Papers,
Technical Reports and Simulation Movies:

http://www.seas.gwu.edu/~dorplr/tab3/NSFProject_GWU_VCU/NSFMain.html

Contact Information

Jason R. W. Merrick

Virginia Commonwealth University

(804) 828 1301 ext. 136

jrmerric@vcu.edu

Jack Harrald, J. Rene van Dorp

The George Washington University

(202) 994 6638

harrald@gwu.edu, dorpjr@gwu.edu