Navigation Technology & Human Factors

Understanding and Managing Risks in the Marine Transportation System (MTS)

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Understanding and Managing Risks
in the MTS Symposium
Fort Schuyler, NY

13 November 2019

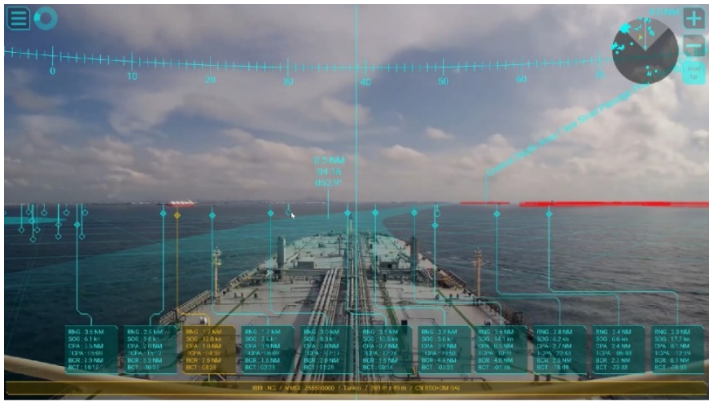
Passing in Houston Ship Channel
http://pixdaus.com/pics/1285391280WU3sTdJ.jpg,
Retrieved 24 October 2019

Overview

--Risks associated with integrated technology

--Impacts in marine transportation system

- Operator Performance
- Decision Making
- Situation Awareness
- Practice of Good Seamanship
- Communication
- Mobility, Agility – *physical, intellectual*



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https://www.rivieramm.com/opinion/opinion/e-navigation-and-advanced-radar-gain-momentum-on-the-bridge-24565, retrieved 8 Sept 2019

Integrated Technology

GlassNav™ -- *NY Harbor*

- Wearable augmented reality display *(WARD)*
- *Integrates* legacy bridge equipment, sensors, displays
- *Situated displays* – operators can focus information

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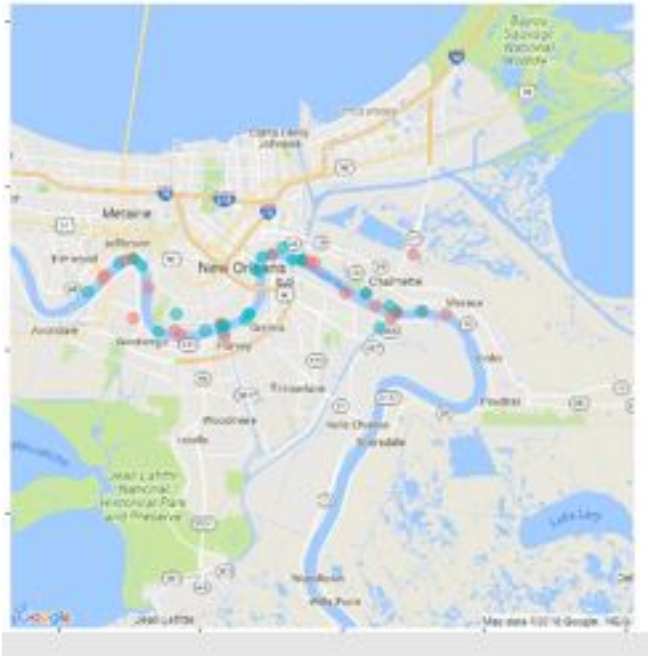
Integrated Technology

Coast Guard Data Risk Analytics *–CG District 8, New Orleans*

- *Integrates* archival & real-time accident, incident, AIS, weather, environmental data
- Captain of the Port Morning Briefing
- Data Analytics, Machine Learning → Predictive Risk Analysis



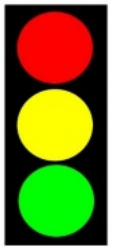
Self Healing Databases

--Flag errors and inconsistencies

--Automatically repair and report

--*Reasoning systems*

--Port, vessel heatmaps



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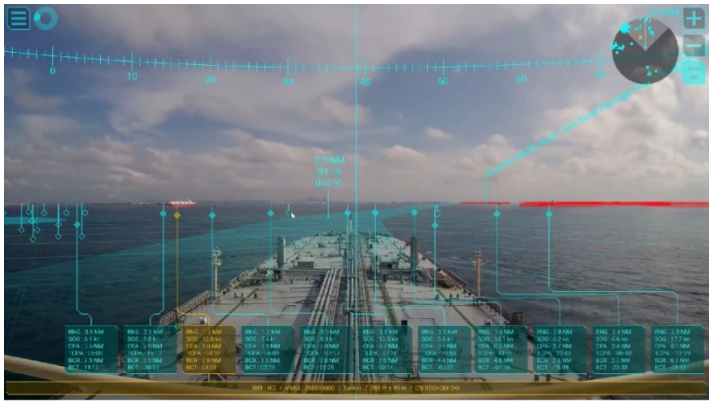

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Risk Event Error Chain

Stage 1 Basic/ Root Causes	Stage 2 Immediate Causes	Stage 3 Incidents	Stage 4 Accidents	Stage 5 Consequence	Stage 6 Impact
• Inadequate skills, knowledge, equipment, maintenance, management • Human and organizational Errors • Org'l culture	• Operational errors • Judgment error • Intentional error •Hazardous situations	•Equipment failure •Propulsion failures •Electrical system failures • Steering failures • Human failures	• Collisions • Groundings • Allisions • Ice collisions • Fire & explosion • Loss of containmt • Lost cargo	•Oil/chemical outflow •Injury •Vessel damage •Persons in peril •Loss of life	• Environmental damage •Loss of life •Vessel loss •Loss of property

I. Decrease Frequency of Root/Basic Causes → II. Decrease Frequency of Immediate Causes or III. Exposure to Hazardous Conditions → IV. Intervene to Prevent Accident if Incident Occurs → V. Reduce Consequences if Accident Occurs → VI. Reduce Impact if Consequence Occurs

Risk Reduction Interventions

Safety Management Programs	*Channel Closure Restrictions*	*Escort Vessels, Redundancy*	*Double Hulls*	*Booming and Containment*

Risk Safety Factor Impacts

Organizational Safety Factors
Hiring Quality Personnel
Safety Orientation
Promotion of Safety
Formal Learning System
Reward Safety
Multicultural Operations

P1-P6

Organizational Safety Performance
accidents
incidents
near losses
of conditions of class
# of port state deficiencies
LTI>=3

Vessel Safety Factors
Responsibility
Communication
Problem Identification
Prioritization of safety
Feedback

P7-P11

Vessel Safety Performance
accidents
incidents
near losses
of conditions of class
# of port state deficiencies
LTI>=3

Individual Safety Factors
Empowerment
Responsibility
Anonymous Reporting
Feedback
Respect
Integrity
Willingness to Change

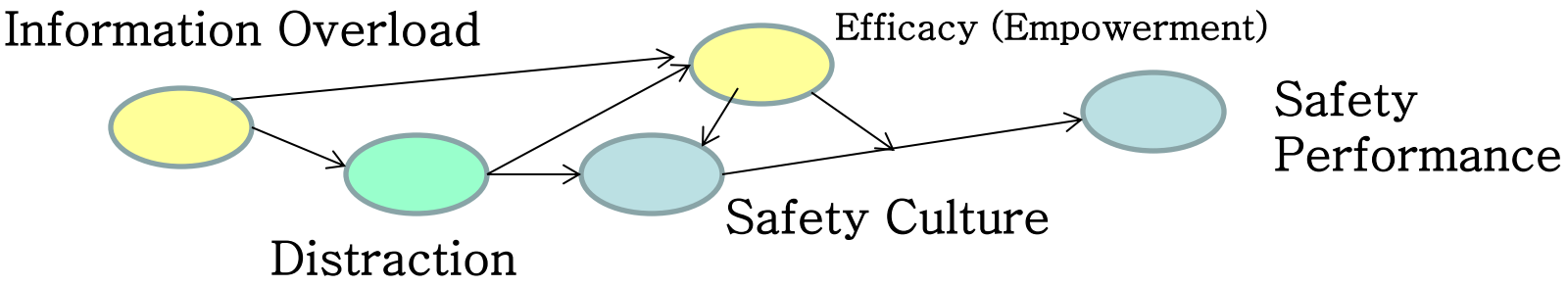
P12-P18

Individual Safety Performance
Perceived safety

http://www.menkent.dk/cliffpics/lookout.jpg, retrieved 9 December 2018

Risk in Integrated Systems

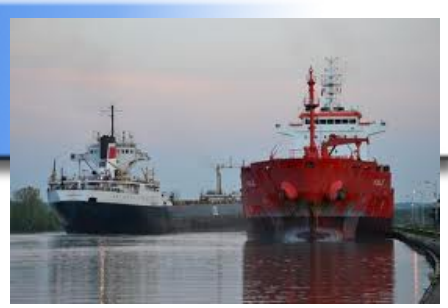
- ***Interdependent network* of safety and risk**
  - *(DeJoy, et al., 2004; Neal, et al, 2000; Zohar, 1980; 2003).*



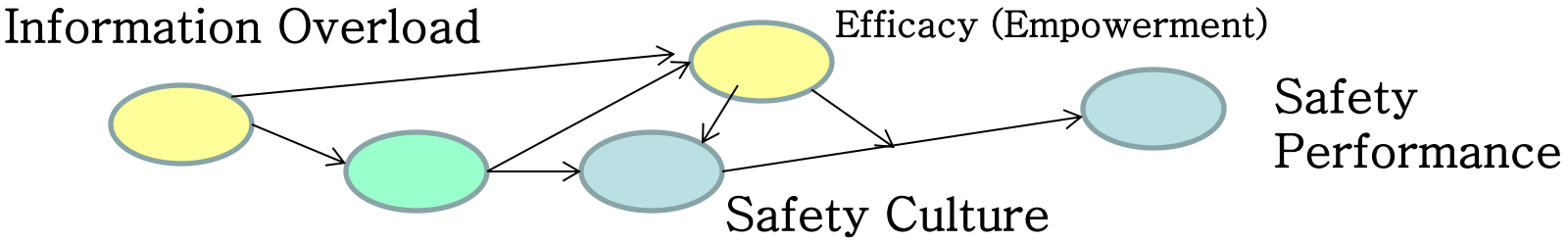
- **Risk migrates *in interdependent systems***
  - *Circumvents barriers*
  - *Organizational 'drift' – USS John McCain, Fitzgerald*

Overseas Houston
http://www.osg.com/siteFiles/SiteManager/108074FE485F3B5B879DD6C3AB711C3A.jpg, retrieved 24 October 2019

Implications



- **Multi-level network data analytics**
  - Integrate legacy & next generation technology
  - Individual, team, vessel, organizational data
  - Model interdependencies and network links
  - Learning systems learn and predict risk patterns



Measuring requisite variety, resilience in risk

- Are risk models sufficiently complex, robust for today's networks?
- Missing nodes, influential nodes

http://t0.gstatic.com/images?q=tbn:ANd9GcQDMElQOYAF7oL-TUY1TkBmwHBchrJulPVeQ17ovstAVreH0-BZQO1IplJ

Retrieved 24 October 2019

References

- Choo, A. & Grabowski, M.R. 2013 "Linking Safety Climate to Safety Improvement Efforts and Operational Disruptions: The Moderating Role of Efficacious Workers" submitted to *Production & Operations Management.* May 17.

- Dhami, H. & Grabowski, M.R. 2011. "Technology Impacts on Safety and Decision-Making over Time in Marine Transportation," *Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability.* September, 225: 1-24. Special issue on Risk and Reliability in Marine Transportation.

- Grabowski, M.R., You, Z., Song, H., Wang, H. & Merrick, J.R. 2010, "Sailing on Friday: Developing the Link between Organizational Safety Culture and Performance in Safety-Critical Systems." *IEEE Transactions on Systems, Man & Cybernetics, Part A, Systems and Humans,* 40:2, March, 263-283. doi: 10.1109/TSMCA.2009.2035300.

- Grabowski, M.R., You, Z., Zhou, Z., Song, H., Steward, M. & Steward, B. 2009."Human and Organizational Error Data Challenges in Complex, Large-Scale Systems." *Safety Science*, 47:9, October, 1185-1194, doi:10.1016/j.ssci.2009.01.008.

- Grabowski, M.R., Ayyalasomayajula, P., Merrick, J.R., Harrald, J.H. & Roberts, K.H. 2007. "Leading Indicators of Safety in Virtual Organizations." *Safety Science.* 45:10, December, 1013-1043. DOI doi:10.1016/j.ssci.2006.09.007.

- Grabowski, M.R., Ayyalasomayajula, P. Merrick, J., & McCafferty, D. 2007. "Accident Precursors and Safety Nets: Leading Indicators of Tanker Operations Safety." *Maritime Policy and Management,* 34:5, October, 405-425.

- National Research Council. 2009. *Risk of Vessel Accidents and Spills in the Aleutian Islands: Designing a Comprehensive Risk Assessment. Special Report 293.* Washington, DC: National Academies Press. http://www.nap.edu/openbook.php?record_id=12443&page=73, retrieved 21 October 2011.

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