

saying they are being safe, so no worries. I'm hoping to find some actual number in between those two." Afenyo and Nevalainen will be validating their models by using data that is available for the Kara Sea in the Arctic Ocean, north of Siberia.

Doug Smith, an Ocean and Naval Architectural Engineering PhD candidate at Memorial University, is taking a holistic approach to building a model that can be used to help prevent shipping accidents from occurring. Since accident information for Arctic shipping is scarce, rather than depending on historical data, he is developing models that use what is learned from successful operations - how work actually gets done - and variability that can impact overall operations. "Variability" refers to an event or circumstance that falls outside of the expectation of the idealised workflow, such as the variable ice conditions that must be dealt with regardless of the expected conditions. "A good communication structure within the organisation is a critical element with respect to safety," says Smith. He adds that operators should have the same mental model of the operation as the engineers and management. The key is to have a consistent and realistic mental model. "Then, things that are outside the norm raise flags for the operators," observes Smith. To build his model, Smith is using the functional resonance analysis method (FRAM), which incorporates an understanding of variability within the system, which is present in both successful operations and accidents. The model will include both variability and the adjustments that have been made to accommodate it successfully, and occasionally, unsuccessfully. He plans to collect information from captains, chief engineers, and others on board ships who have first-hand knowledge of shipping operations and variability, and what was done to keep operations safe.

Dr. Brian Veitch, professor of Ocean and Naval Architectural Engineering at Memorial University, supervises Smith's research. "Rather than focus

exclusively on past accidents as a source of insight, we're trying to understand why shipping operations are almost always successful," he says. "That is, we're investigating who and what make an operation robust and resilient in the face of changing circumstances." He sees great value in taking a human factors approach to preventing shipping accidents. Recently, Afenyo took a flight to the University of Helsinki to collaborate with Nevalainen for three months. "They each have a piece of the puzzle," Dr. Veitch says, "and they're going to join

them so they can do something bigger than the sum of the parts." They will be developing a risk assessment model for Arctic shipping and applying it to a case study in the Kara Sea. **FE**

Afenyo, Nevalainen, and Smith plan to publish the results of their work in scientific papers. Information regarding their findings will be available on the Research Center of Excellence for Arctic Shipping and Operations web site: www.cearctic.aalto.fi/en/



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