

A Systems Approach to Modelling Emergent Behaviour in Maritime Control Systems Using the Composition, Environment, Structure, and Mechanisms Metamodel

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Abstract : Society increasingly relies on complex systems whose behaviour is determined, not by the properties of each part, but by the interaction between them. The behaviour of such systems is emergent. Modelling emergent system behaviour requires a systems approach that incorporates the necessary concepts that are capable of determining such behaviour. The CESM metamodel is a model of system models. A set of system models needs to address the elements of CESM at different levels of abstraction to be able to model the behaviour of a complex system. Modern ships contain numerous sophisticated equipment, often accompanied by a local safety system to protect its integrity. These control systems are then connected into a larger integrated system in order to achieve the ship's objective or mission. The integrated system becomes what is commonly known as a system of systems, which can be termed a complex system. Examples of such complex systems are the dynamic positioning system and the power management system. Three ship accidents are provided as examples of how system complexity may contribute to accidents. Then, the three accidents are discussed in terms of how the Multi-Level/Multi-Model Safety Analysis might catch scenarios such as those leading to the accidents described.

Keywords : emergent properties, CESM metamodel, multi-level/multi-model safety analysis, safety, system complexity, system models, systems thinking

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