Using MBSE to Develop Automated and Cost-Effective Access to Supply Chain Analysis

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Discrete event logistics systems (DELS) are a class of dynamic systems that are defined by the transformation of discrete flows through a network of interconnected subsystems; e.g., supply chain, manufacturing plants, transportation networks, warehouses, health care delivery systems, etc.

Automated and cost-effective access to multiple analyses from a single conceptual model of the target discrete event logistics system would provide much broader support for operational decision making and system optimization.

To provide automated access from a formal system model to multiple analysis tools, such as discrete event simulation or optimization, we extend current model-based systems engineering (MBSE) methodologies by introducing a new model to model transformation method based on object-oriented creational patterns from software design.

Object-Oriented, Network Based Transformation

Generative Methods Based on Creational Patterns

Creational patterns abstract the instantiation process by encapsulating the knowledge about which concrete classes the system uses and hiding how instances of these classes are created and assembled.

Organization of Generative Process

1) Abstract Factory pattern
   - Used to take advantage of the network flow abstraction by declaring an interface for creating products and declaring an abstract class for each of the products.
2a) Single parameterized concrete factory
2b) Multiple concrete factories, one for each product to be created
3) Prototyping from Model Library
   - Build and debug the reusable simulation components in their native simulation environment.
4) Builder Classes to make modifications
   - Since we created our simulation from stack objects cloned from a model library, need a method to modify the internal machinery of each product.

Future Work on Bridging Abstractions: A Metamodel of Operational Control

Future work is focused on developing a canonical abstraction of operational control for a broader class of systems called Discrete Event Logistics Systems (DELS).

This canonical abstraction incorporates a metamodel of the control questions that are addressed in the related literature. It then formalizes current reference architectures for DELS to support the explicit specification of these control questions. This formalism allows the control problem to be specified within the context of the system, provides an interface to connect optimization tools to solve the control problem, and a common expression and implementation of the output and solution to the control problem.

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