Integrated Modeling of Supervisory Control Theory and Model-Based System Engineering

Xiaoshan LU, Laurent PIÉTRAC, Éric NIEL

Université de Lyon, CNRS, INSA-Lyon, AMPERE, F-69621 Villeurbanne, France

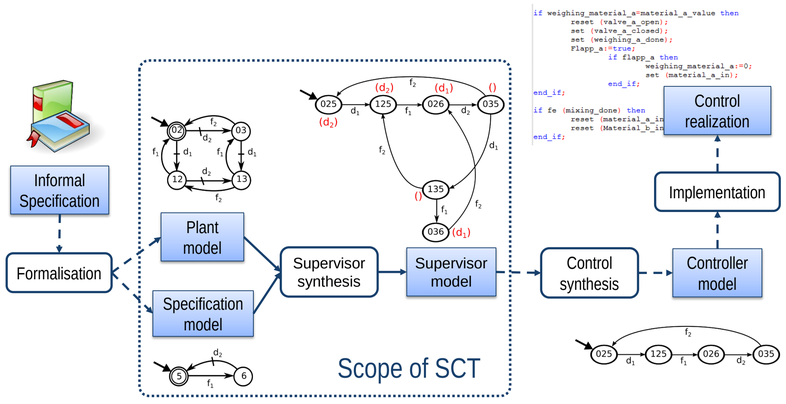
contact : **laurent.pietrac@insa-lyon.fr**

CONTEXT

SUPERVISORY CONTROL THEORY

The Supervisory Control Theory (SCT) is one of the most important modeling theories for supervisor synthesis and verification for discrete event system (DES). The advantages are:

- Rigorous mathematic modeling
- Numbers of existing theoretical methods and algorithms
- Tool supports: TCT, Desuma, Supremica …



Inspired by : J. Zaytoon and B. Riera, Synthesis and implementation of logic controllers – A review, Annual Reviews in Control, vol. 43, 2017, pp. 152–168

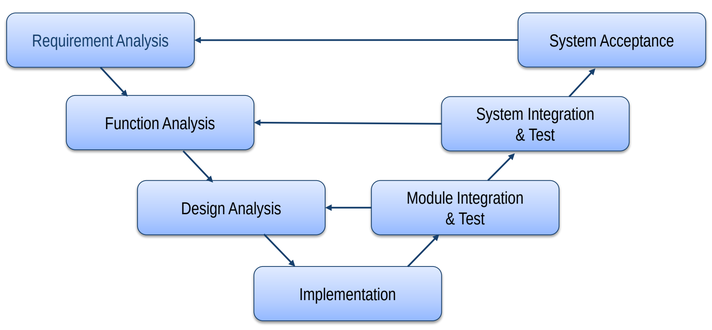
However, there are still gaps between theoretical developments and applications of SCT in engineering practice. Why ?

Due to the scope of SCT, there isn't:

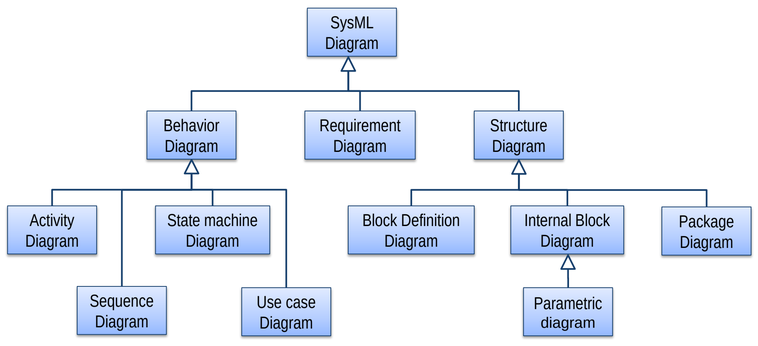
- Links between informal requirements and formal specifications
- Structure models
- Implementation models
- A global framework to standardize the modeling process from informal specification to control realization

MBSE

In engineering practice, Model-Based System Engineering (MBSE) is a power methodology for system design. V-model is a typical modeling process in MBSE.

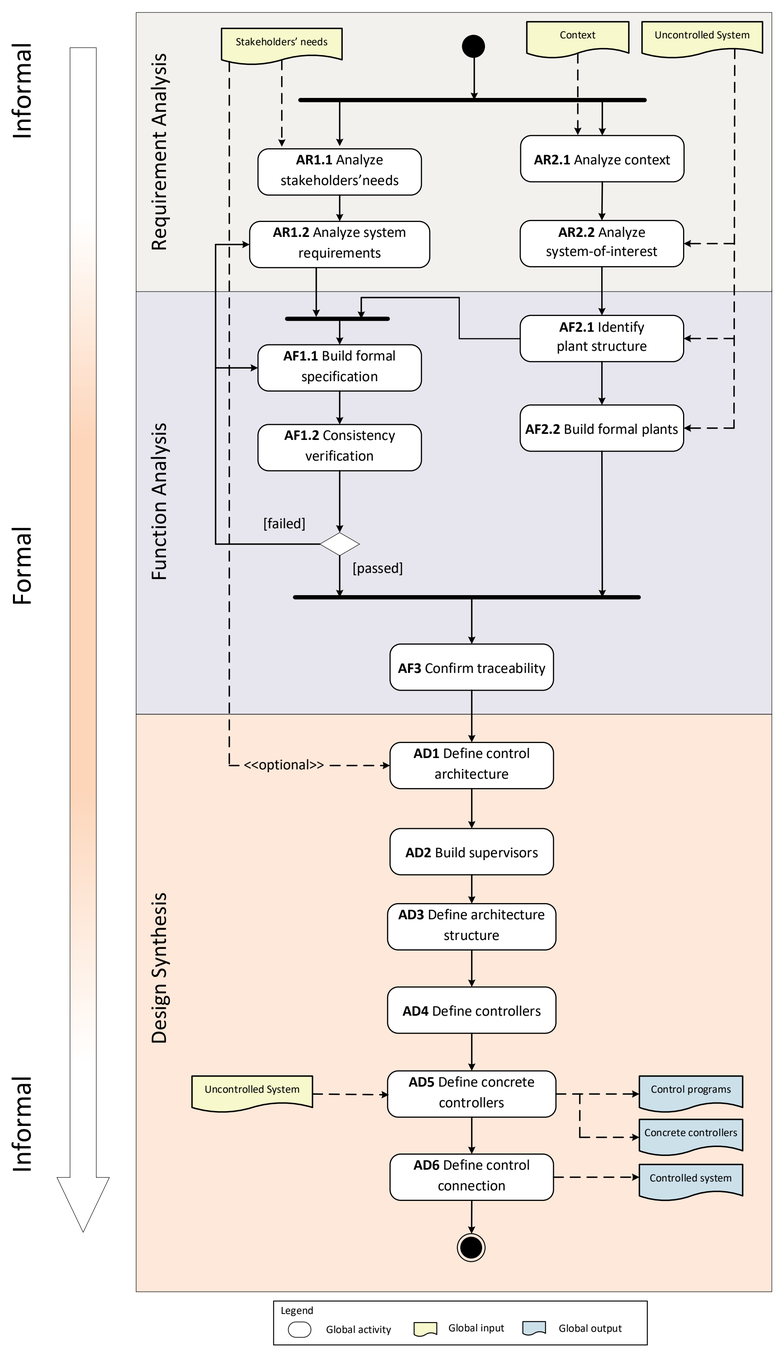


SysML is a graphic modeling language for systems engineering. SysML includes nine diagrams so as to provide a standardized and unified modeling language by which system design can be visualized and modeled from different perspectives. Therefore, SysML can be regarded as a partial solution to make up with the limitations of SCT.

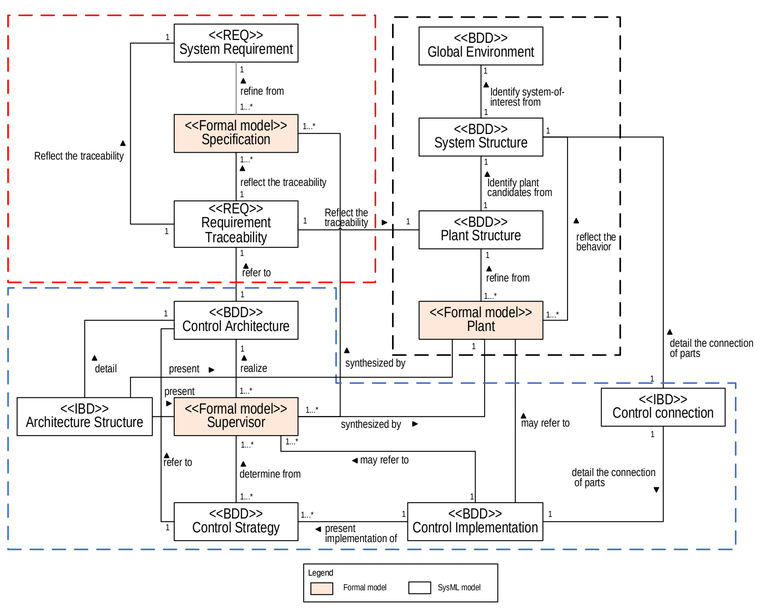


PROPOSED FRAMEWORK

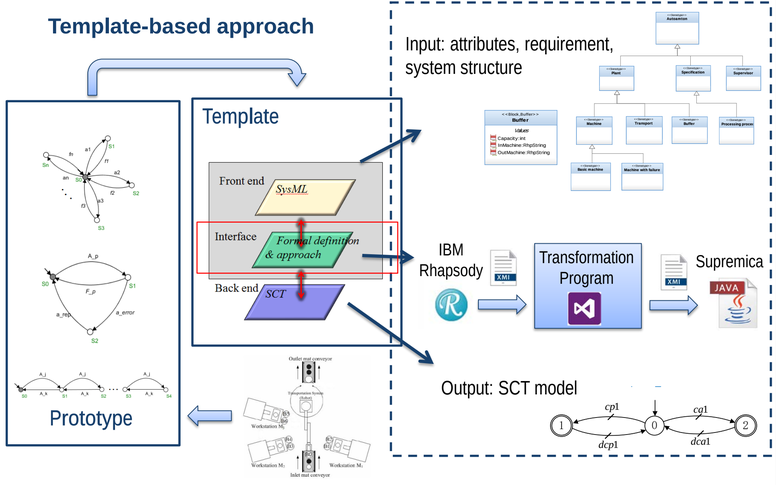
MODELING PROCESS



MODELS INTEGRATION



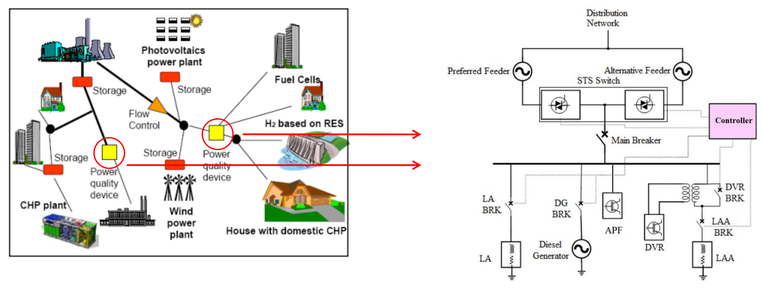
TEMPLATE-BASED APPROACH



RESULTS

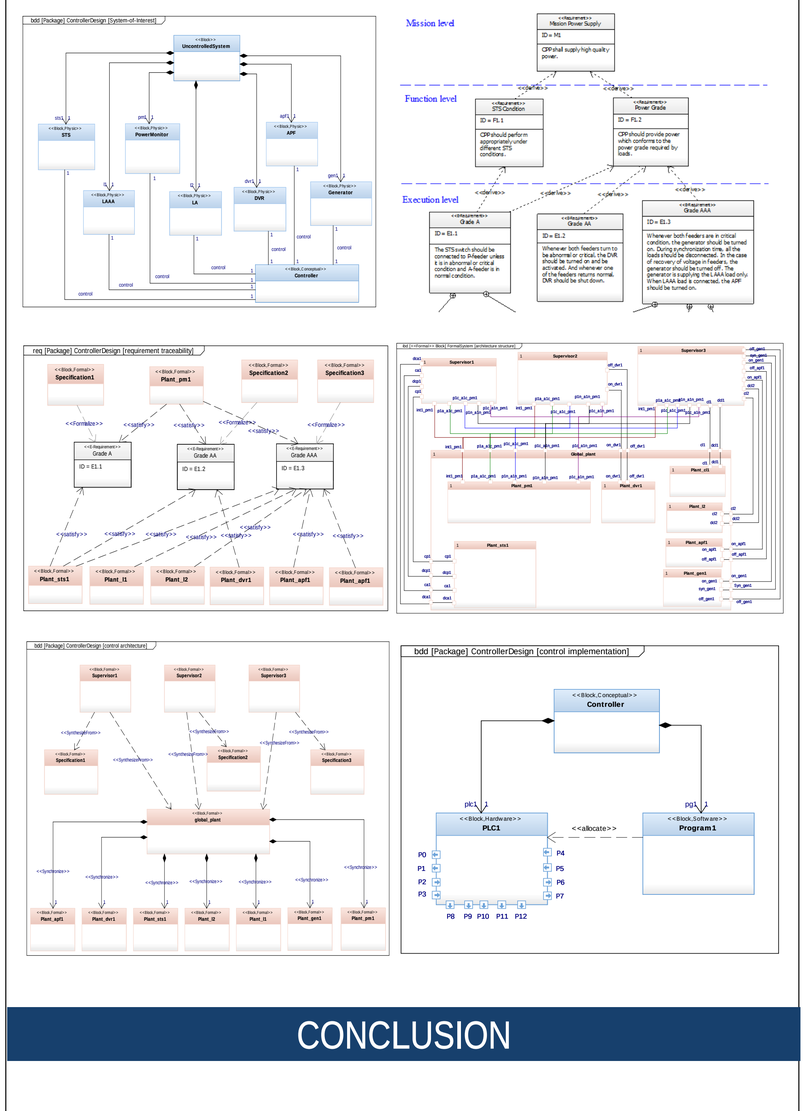
CASE STUDY

Studied system: a Custom Power Park (CPP)



(Kharrazi, Mishra, & Sreeram, Discrete-Event Systems Supervisory Control for a Custom Power Park, IEEE Transaction on Smart Grid, vol. 10, no. 1, 2019)

Examples of models



CONCLUSION

The proposed framework:

- Integrates SysML language and SCT paradigm
- Defines a global process, from initial needs to final program
- Includes 13 viewpoints on the system, from requirements and system to control to controller
- Ensures traceability of the modeling choices by links between models
- Improves the reusability of models with a template-based approach
- Is supported by modeling tools (Rapsody and Supremica) and XMI standard

PERSPECTIVES

- Extend the template-based approach in order to realize an efficient and accurate way of formalization. For example, build an implementation of model libraries for specific domains
- Apply the framework on more case studies, to prove the feasibility of the proposed framework
- Study he semantic of behavior diagrams in SysML and their semantic links with Automata
- Build a tool to support the framework