Recent Advances in System Modelling and Simulation

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The purpose of the Research

Comparative Research between several languages, methods and modeling tools to examine what is the most effective combination for the system engineer

Research questions

- What is the "ideal" modeling method for systems engineering and in what layer (system or components) should it be performed?
- What is more effective:

  A modeling tool accompanied by a known language / method that has the ability of link to the physics of the system parts within the same tool **or** a combination of different system modeling and drawing tools?

Research framework

Preliminary screening of the variety of languages / methods and modeling tools in the research

A decision of using tools and languages recognized in industry in the country

The tools and methods selected are:

- Modeling tools: System Composer and Enterprise Architect
- Modeling Methods/languages: ECSAM and SysML
- Diagram tools: Visio

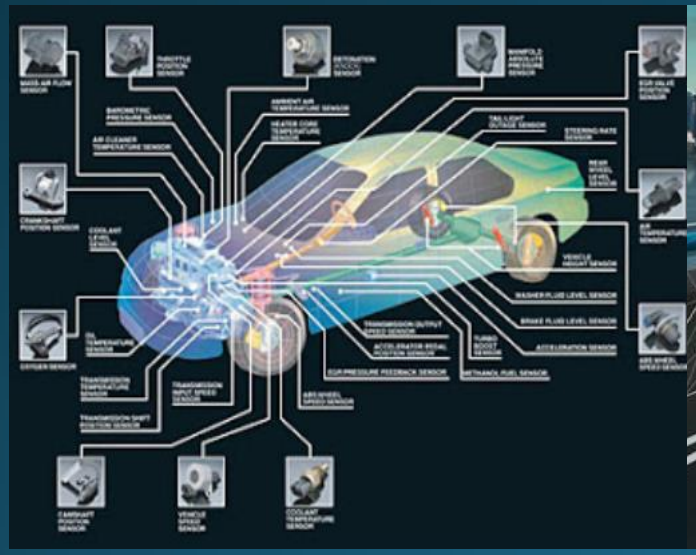
The relationships between the languages / methods of the modeling tools and the drawing tools that researched:

1. System Composer with ECSAM
2. Enterprise Architect with SysML
3. Visio with ECSAM

Test Cases

"360-degree Car Damage Monitoring"

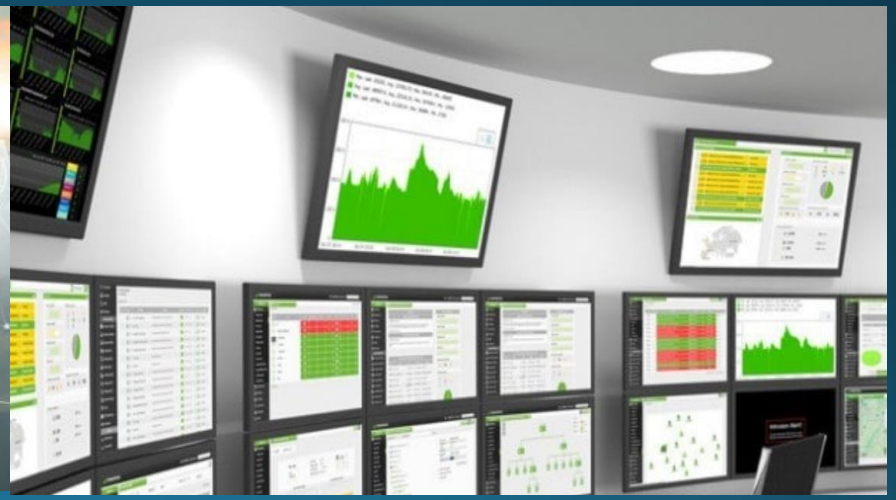
- "360-degree car damage monitoring" - a high-complexity integrated system with sub-systems with medium / high complexity



"Smart train carriages management"

- "Smart train carriages management" - an integrated system with medium / high complexity with many identical subsystems with low complexity

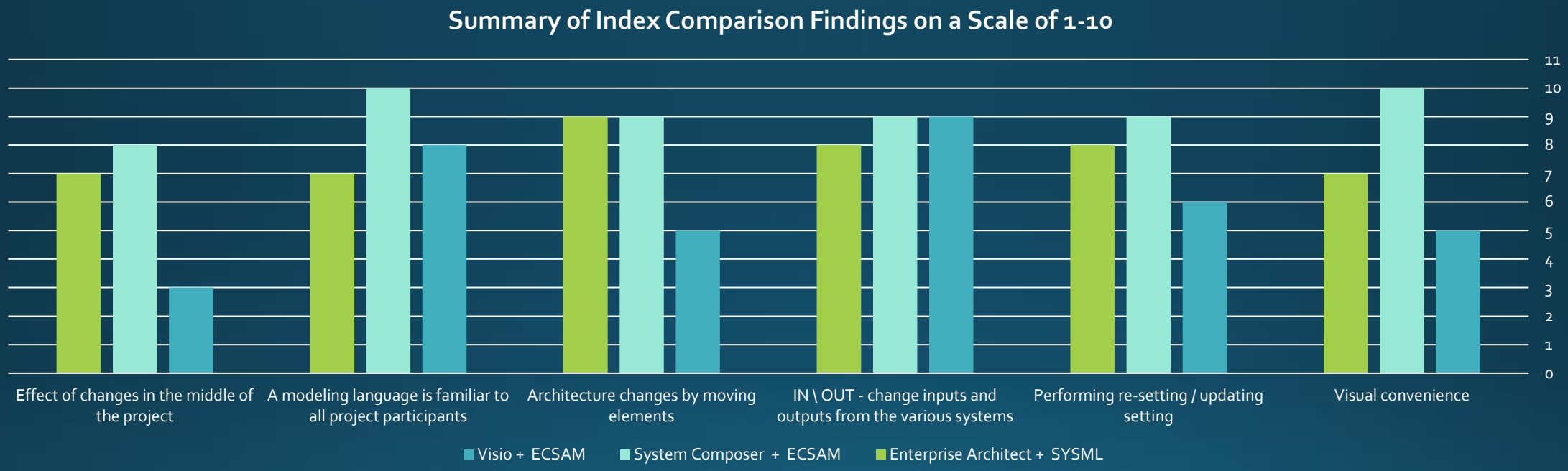




Indicators for examining research questions

Indicators	Weights
Visual convenience	20%
Performing re-setting / updating setting	20%
change inputs and outputs in the various systems - IN \ OUT	10%
Architecture changes by moving elements	10%
A modeling language is familiar to all project participants	10%
Effect of changes in the middle of the project	30%

Summary of research results



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9	System Composer + ECSAM
7.5	Enterprise Architect + SysML
5.3	Visio + ECSAM

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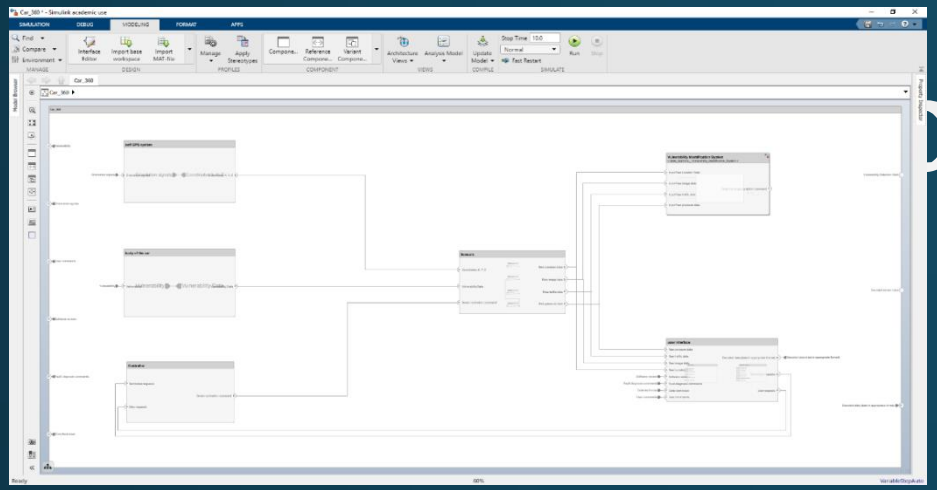

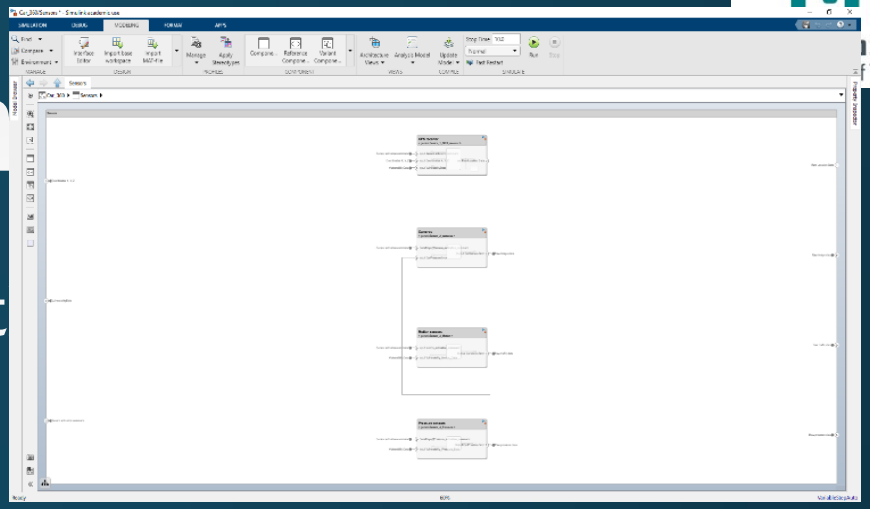

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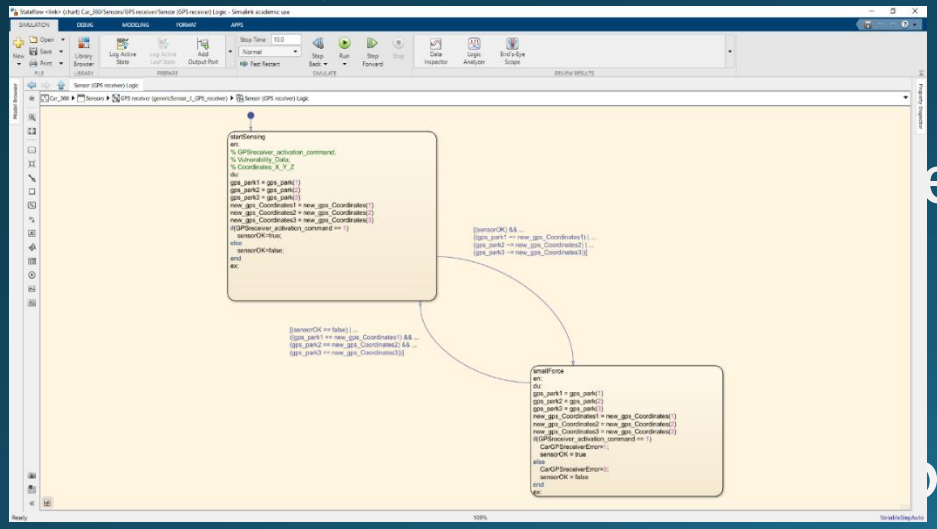
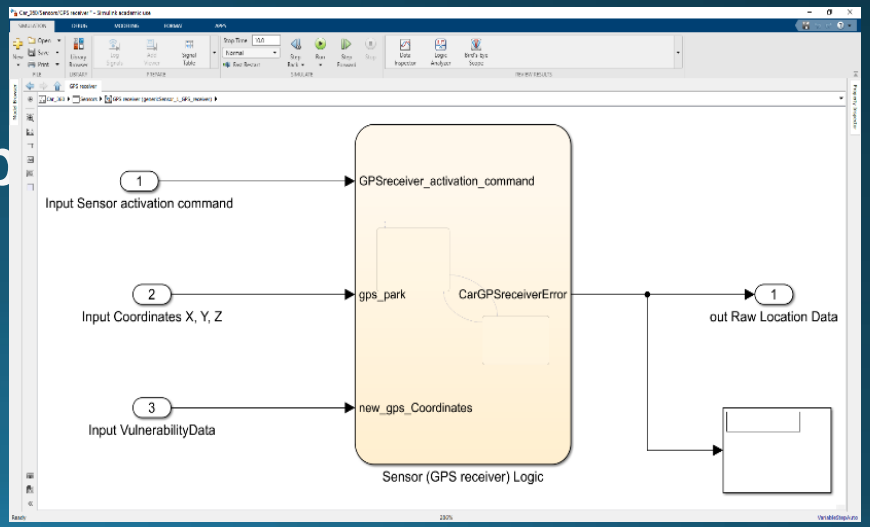
- Complex simulation capabilities, with capabilities for analyzi , building models, and running simulations in a simple way





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Design validation by simulation (2/2)

Example of a Scenario: Accident ➡ damage to the body of the car		Description of the Scenario Trial
	Trial 1	The pressure sensors detected a blow to the car body at 30k psi, The pressure sensors detected the blow that was below the low threshold. Due to the debilitating damage, the camera sensors were not activated and no alert was sent to the control center.
	Trial 2	The pressure sensors detected a blow to the car body at 40k psi, The pressure sensors detected the blow that was above the low threshold, but below the high threshold, due to the moderate impact the camera sensors were not activated and an alert was sent to the control center.
	Trial 3	The pressure sensors detected a blow to the car body at 130k psi, The pressure sensors detected the blow that was above the high threshold, due to the strong impact the camera sensors were activated and an alert was sent to the control center.

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Main Conclusions of the Research

- There was no need for a special tool use course
- The use of modeling tools makes it possible to reduce the investment time in "free drawings"
- Working with a single modeling tool that includes all aspects of the use phase enables overall system modeling as well as detailed components modeling and integration
- The objective to perform systemic simulations, as comprehensive as possible, as early as possible in the project, using automation is close at hand
- There is a great chance of assimilation in industry in complex projects - further research is planned and collaboration with industry

Future Directions

- Continuation of current research in collaboration with industry
  - Linking the systemic layer to the physical modeling of the components
  - Automation of system simulation and report generation
  - Use of tools from the world of "OPEN SOURCE" for the initial concept phase
  - Examining the continuation and deepening of the research within the framework of a third degree
- Further research in industrial modeling, analysis and system simulation using SysML v2
- Using of tools as standard in HIT systems engineering courses (starting 2020-21 academic year)
- Option to use tools and examples in IoT and CIM courses

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Questions ?

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Thanks !