CENTRE OF EXCELLENCE EPIC
Production Informatics and Control

Simulations – tool and enabler to achieve advanced logistic systems

Szimulációk - eszköz és lehetőség a korszerű logisztikai rendszerekhez

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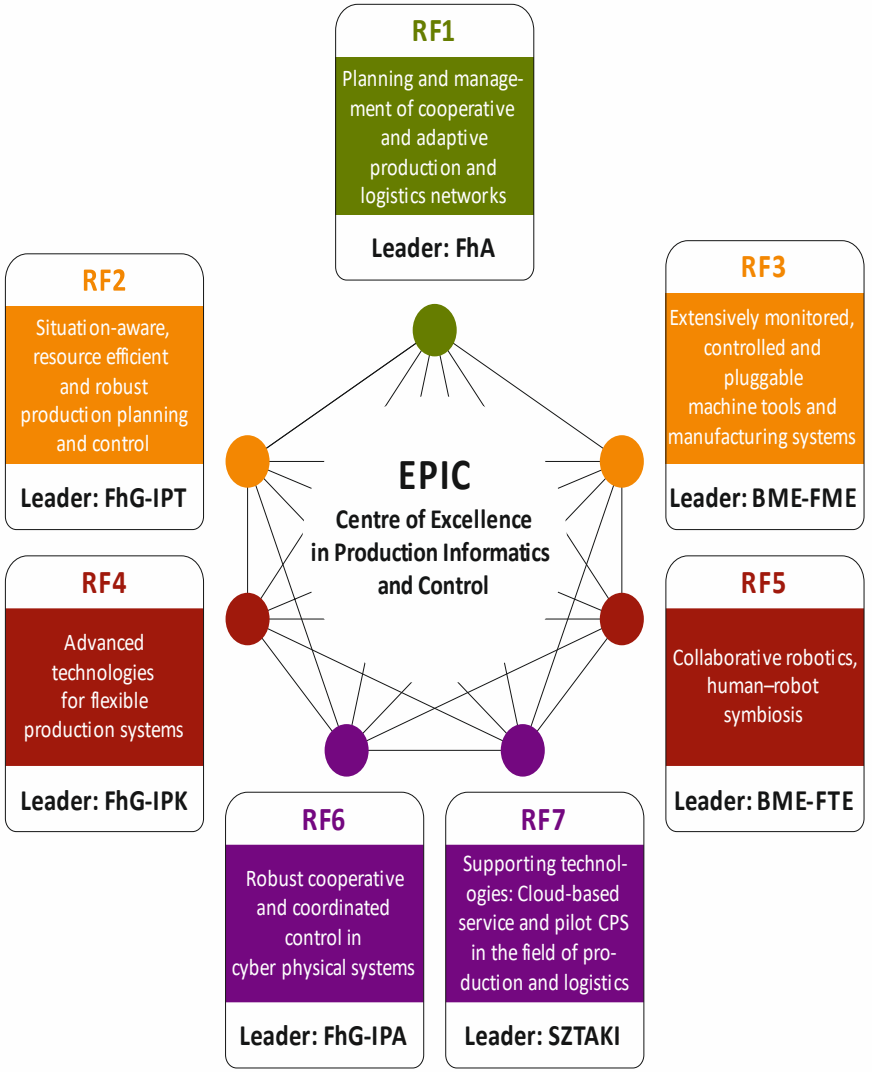
Introduction – BME ALRT

- 1952. Department of Lifting Machines and Material Handling Machines
- 1969. Department of Building Machines and Material Handling Machines
- 2000. Department of Building Machines, Material Handling Machines and Manufacturing Logistics
- 2013. Department of Material Handling and Logistic Systems

Aim of the project

Mission

The mission of EPIC CoE - as a leading-edge knowledge centre of **cyber-physical production systems** - is to accelerate innovation, realize industrial solutions, train new generations of highly qualified professionals and support the development of a sustainable and competitive European manufacturing ecosystem



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Abstract of the paper

The paper presents evolution of the simulations' application in logistics.

After discussing the conventional application areas two areas of development have been emphasized:

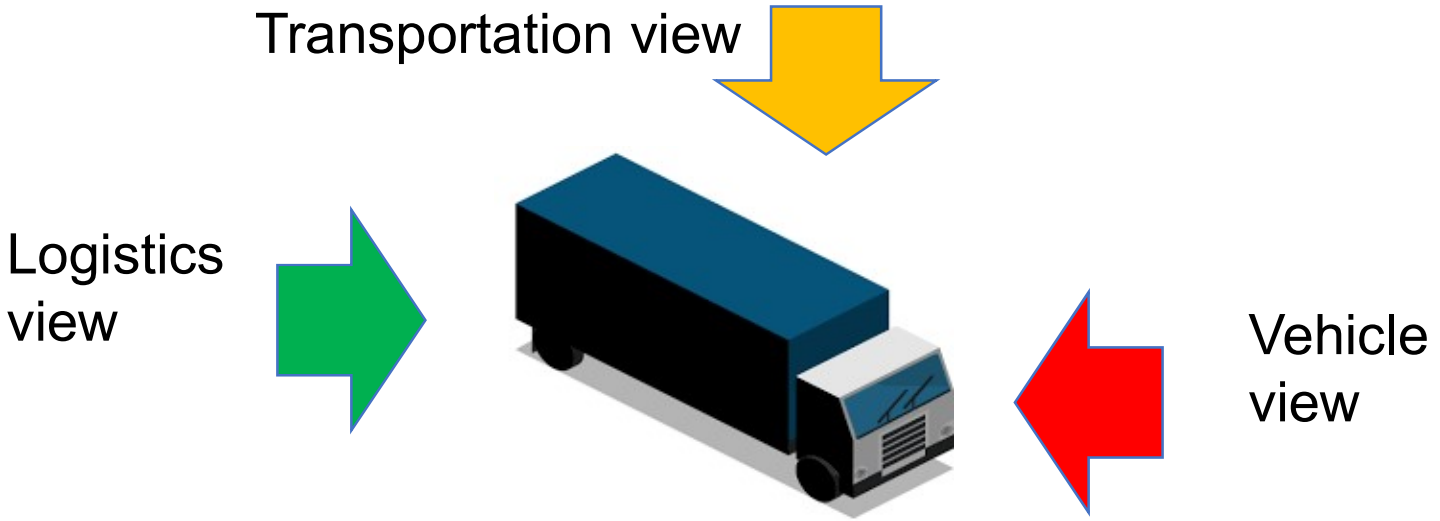
- Serious games
- Ontologies

Finally conclusions are drawn, which possibilities are opened by the use of the above areas in the conventional simulations.

Main conclusion of the paper is that simulations dispose of serious reserves which exploitation would bring several innovative solutions.

Vehicle technology, transportation, logistics

The above three disciplines observe the same „thing” but from different aspects:

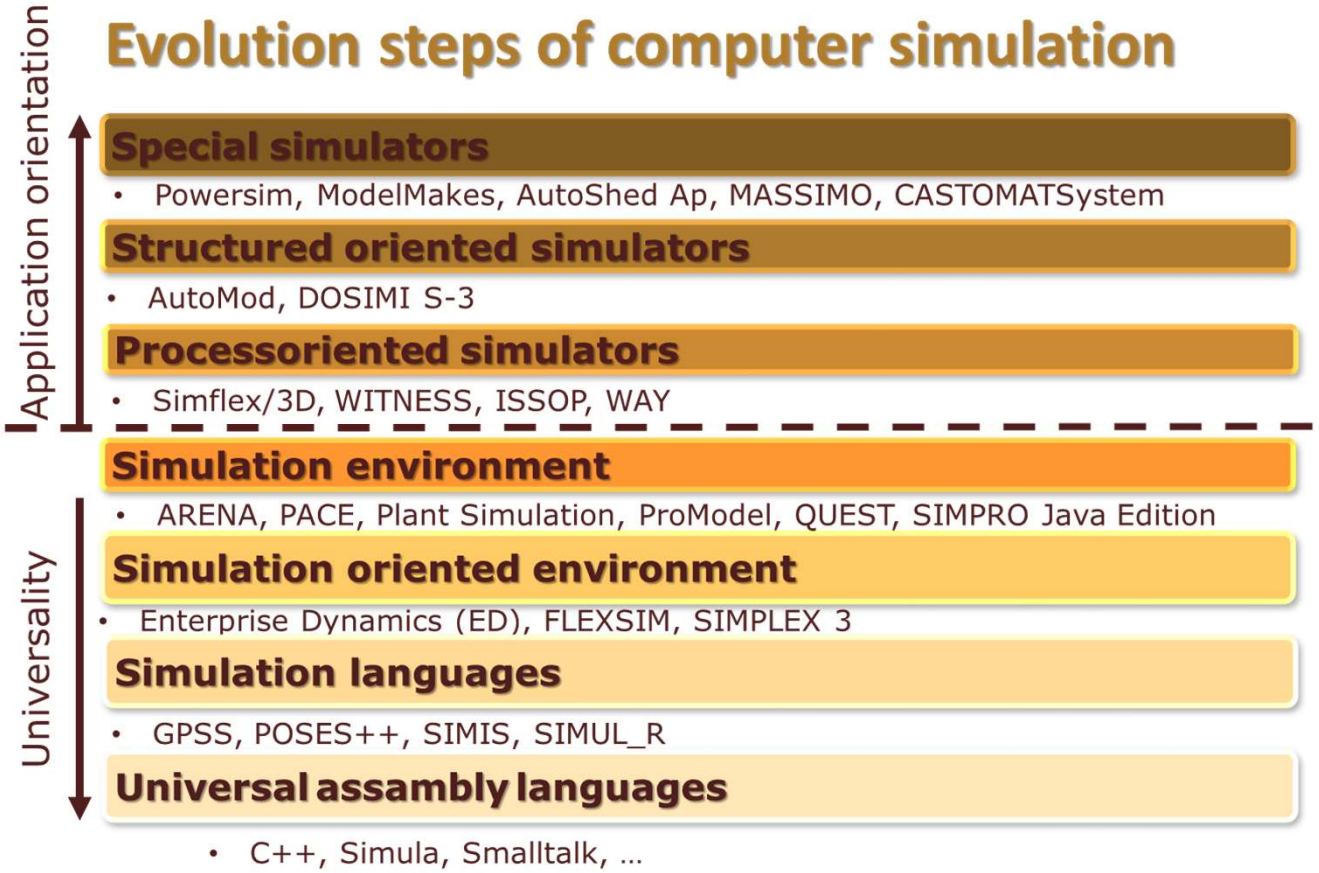


Logistics is generally the detailed organization and implementation of a complex operation. In a general business sense, logistics is the management of the flow of things between the point of origin and the point of consumption in order to meet requirements of customers or corporations. The resources managed in logistics can include physical items such as food, materials, animals, equipment, and liquids; as well as intangible items, such as time and information. The logistics of physical items usually involves the integration of information flow, materials handling, production, packaging, inventory, transportation, warehousing, and often security.

Basics of logistic simulations

Simulation is an imitation of the operation of a real-world process or a system over time in a safe environment. (…) Simulation is an indispensable problem solving methodology for the solution of many real-world problems. Simulation is used to describe and analyze the behavior of a system, ask what-if questions about the real system, and aid in the design of real-system.

Banks (2001)

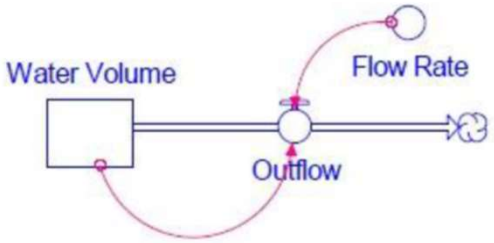


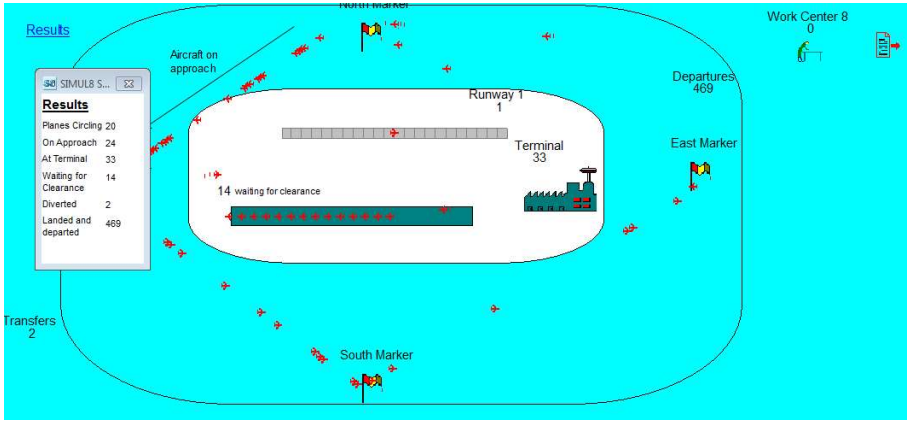
Basics of logistic simulations

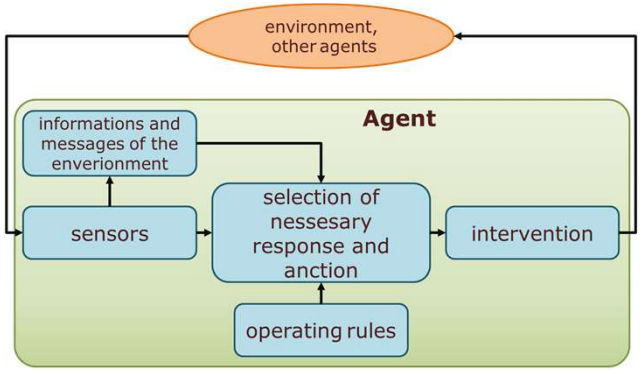
SD
System Dynamics

DES
Discrete Events Simulation

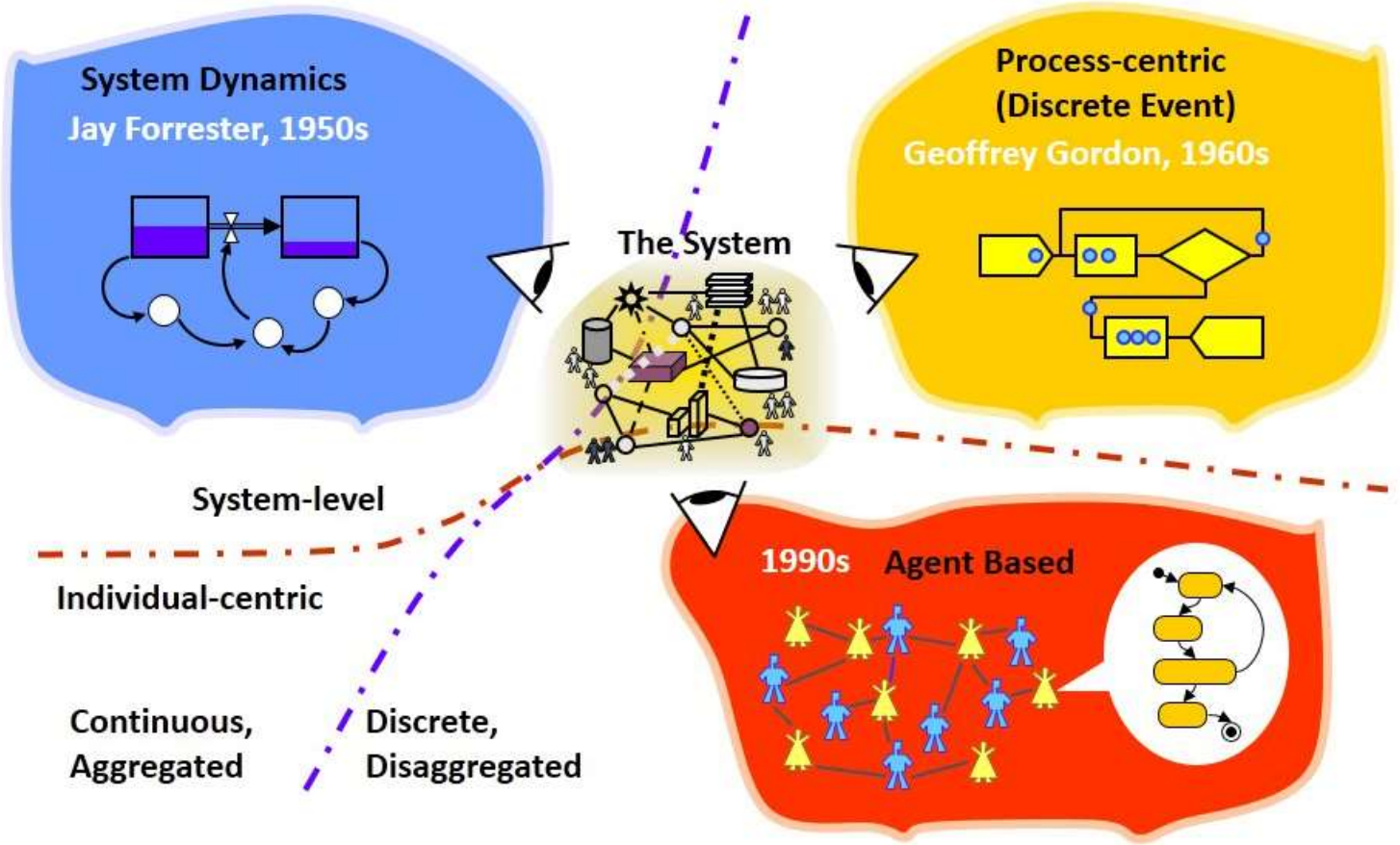
ABS
Agent Based Simulation



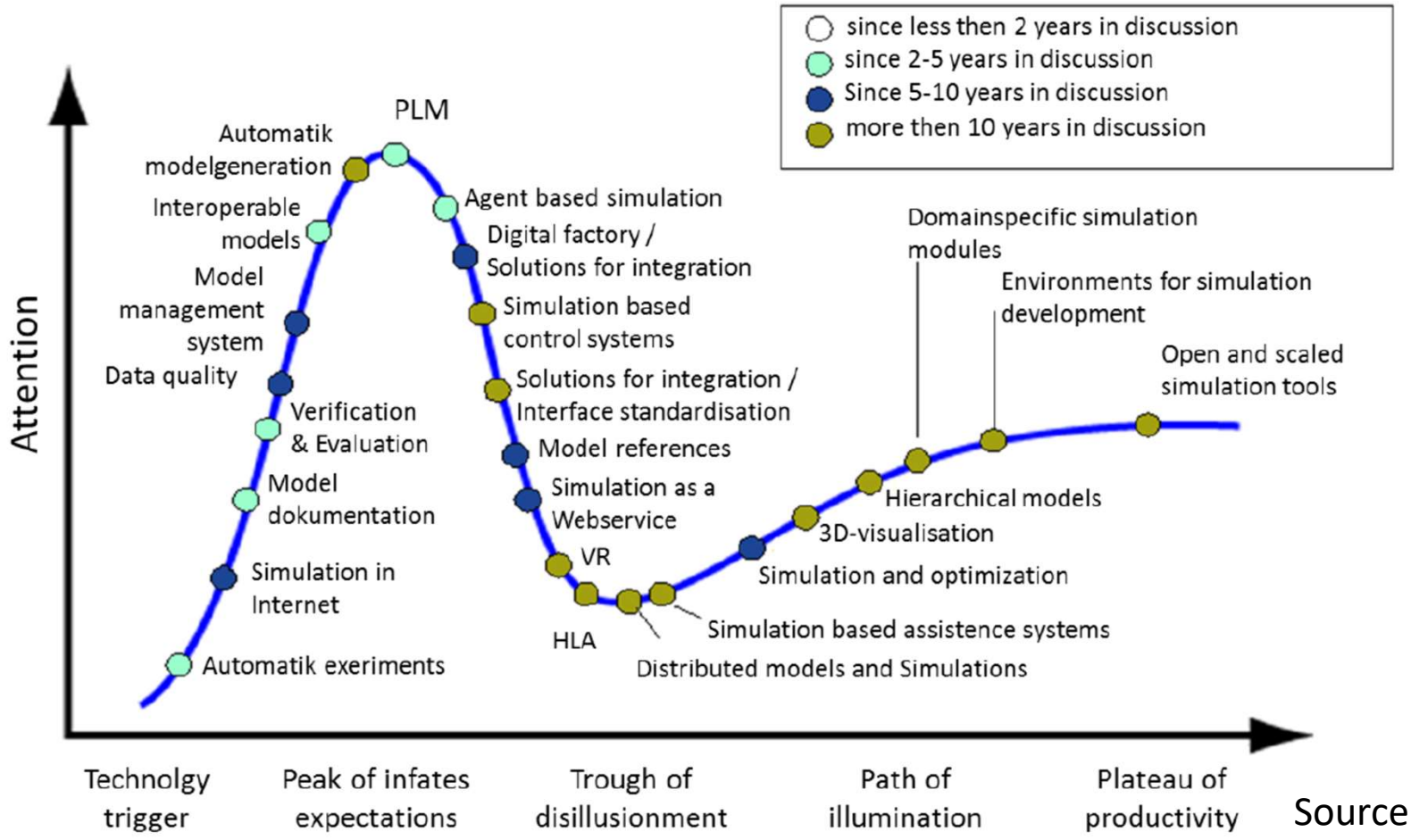




Basics of logistic simulations



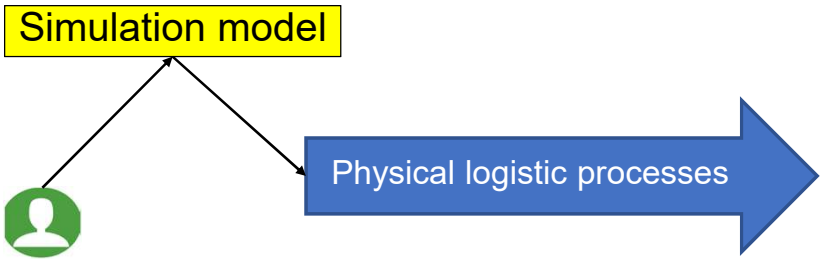
Trends in logistic simulations



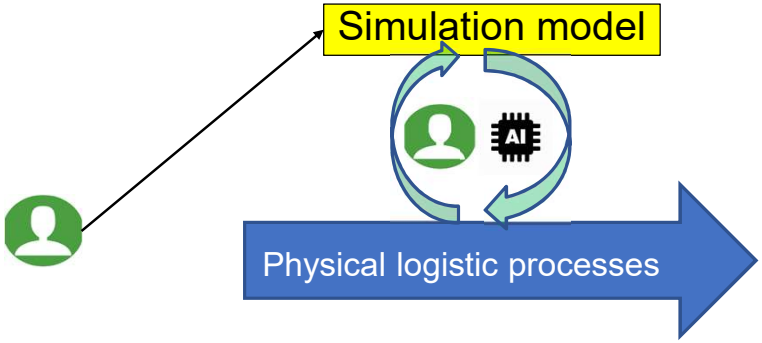
Source: Wenzel (2009)

Evolution of logistic simulations

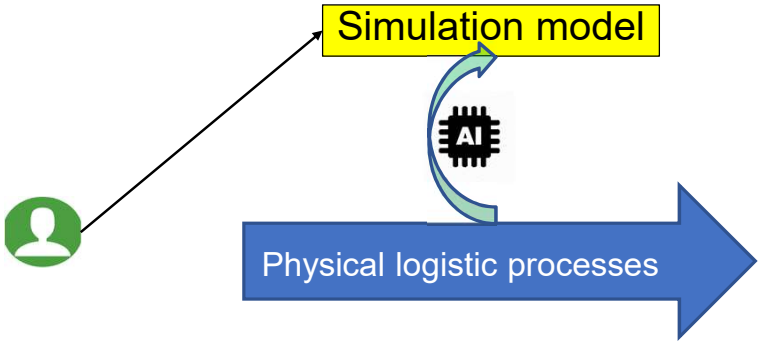
Simulation for the planning phase



Simulation for the daily use

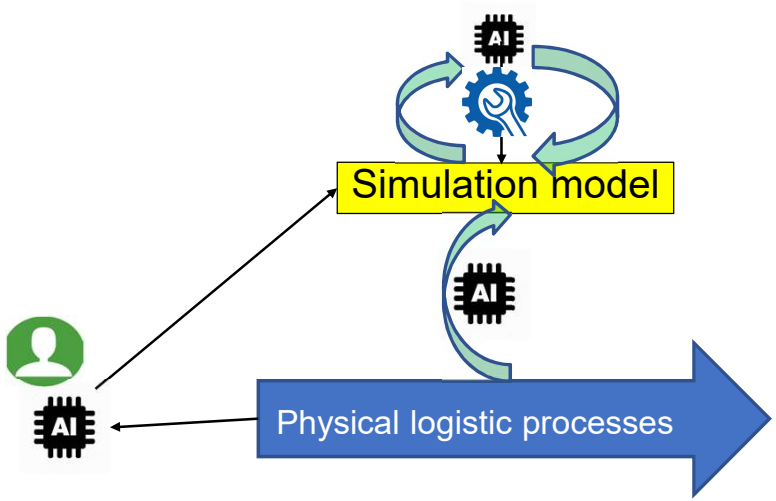


Simulation as a digital twin

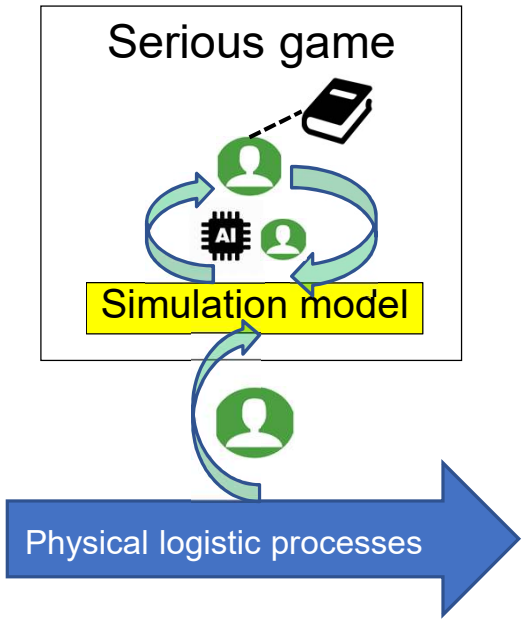


Evolution of logistic simulations

Adaptive simulations

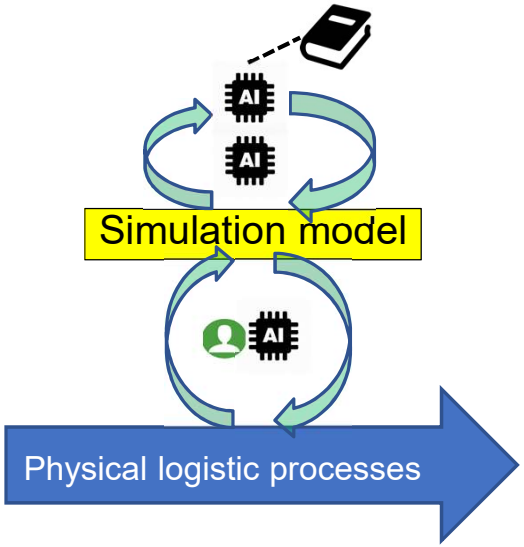


Simulation as a serious game

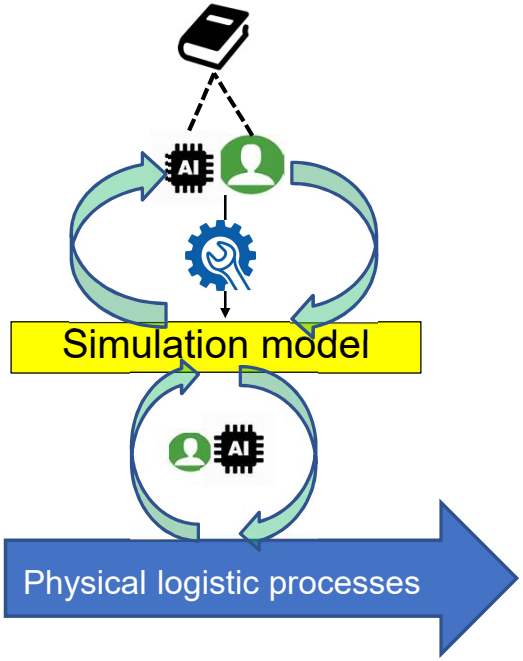


Evolution of logistic simulations

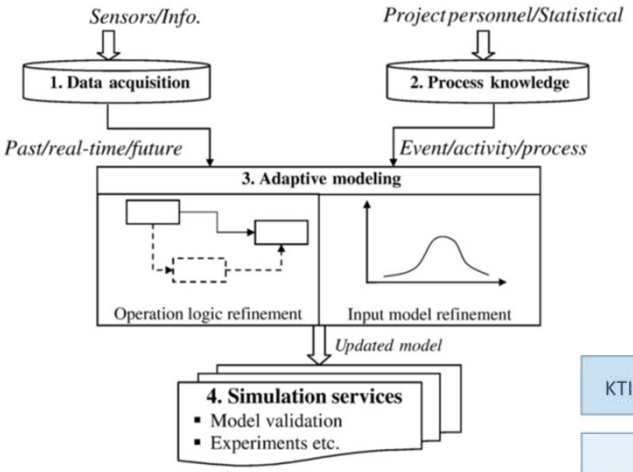
Learning systems (AI)

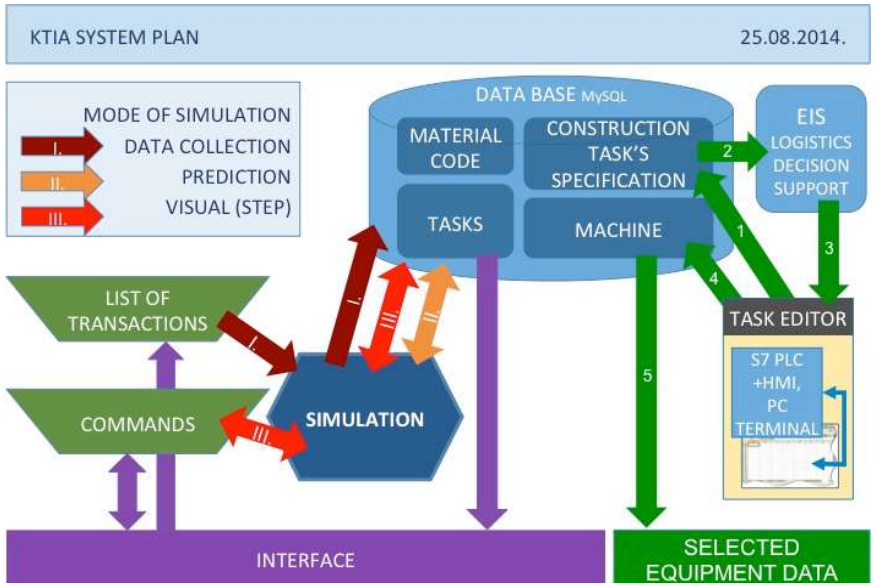


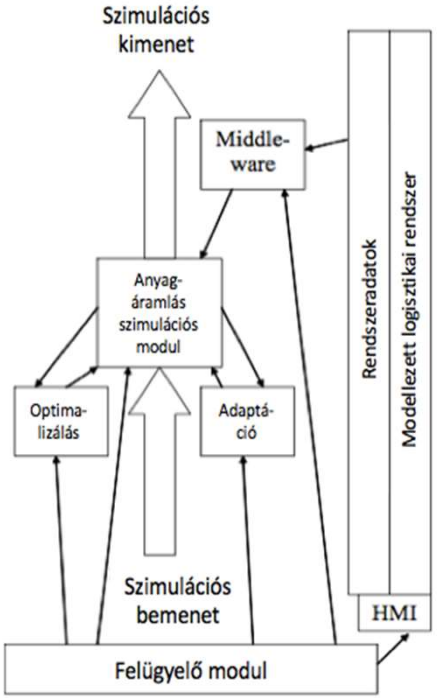
Collaborative, adaptive simulations



Examples of adaptive simulations







Solutions for city logistics

Table 1. Smart Logistics Solutions (Source: NOVELOG, 2016a).

Cooperative Logistics	Administrative & regulatory schemes and incentives
• Multimodality for urban freight	• Loading/Unloading areas and parking
• Urban consolidation centres	• Access: time windows, emission zones
• Trans-shipment facilities	• Access by load factor
• ITS for freight monitoring and planning/routing	• Multi-users lanes
• Home deliveries system	• Enforcement and ITS adoption for control and traffic management
• E-commerce system for small shops	• Businesses recognition scheme
• Cargo bikes for B2B and B2C	• Public transport indirect promotion for shopping
• Electric vehicles diffusion in businesses (zero-emission transport)	• Urban planning measures
• Reverse logistics integration into supply chain	• Harmonization and simplification of city logistics rules
• City lockers	• Off peak deliveries
	• Public transport for freight

… with extensive application of simulations

Table 2. Review of city logistics model techniques.

Logistics Solutions	Simulation Technique	Stakeholder Category	Author
Cargo bikes for B2B and B2C, Home deliveries system	Traffic simulation	Public Authorities	Munuzuri *et al.* (2010)
ITS for freight monitoring and planning/routing(Route-based guidance for delivery/pick up vehicles)	Traffic simulation	Other stakeholders	Walker and Manson, (2014)
Access by load factor (Truck ban and tolling of urban expressway)	Multi-agent systems	Supply Chain Stakeholders, Other stakeholders	Taniguchi and Tamagawa (2005)
E-commerce system, Access by load factor, Access: time windows, emission zones, Enforcement and ITS adoption for control and traffic management	Systems Dynamics	Public Authorities	Qiu *et al.* (2015)
E-commerce system (vehicle routing and scheduling)	Multi-agent systems	Supply Chain Stakeholders, Other stakeholders	Teo *et al.* (2012)
Urban Consolidation Center (Dynamic Usage of UCC)	Multi-agent systems	Supply Chain Stakeholders, Public Authorities	Van Duin *et al.* (2012)
Urban Consolidation Center &Loading/Unloading areas and parking (Joint delivery systems)	Multi-agent systems	Supply Chain Stakeholders	Wangapisit *et al.* (2014)
Intermodal terminals for urban freight	Multi-agent systems	Supply Chain Stakeholders	Graudina and Grundspenkis (2005)

Increase of relevance in the areas of application

Recent trends (city logistics examples):

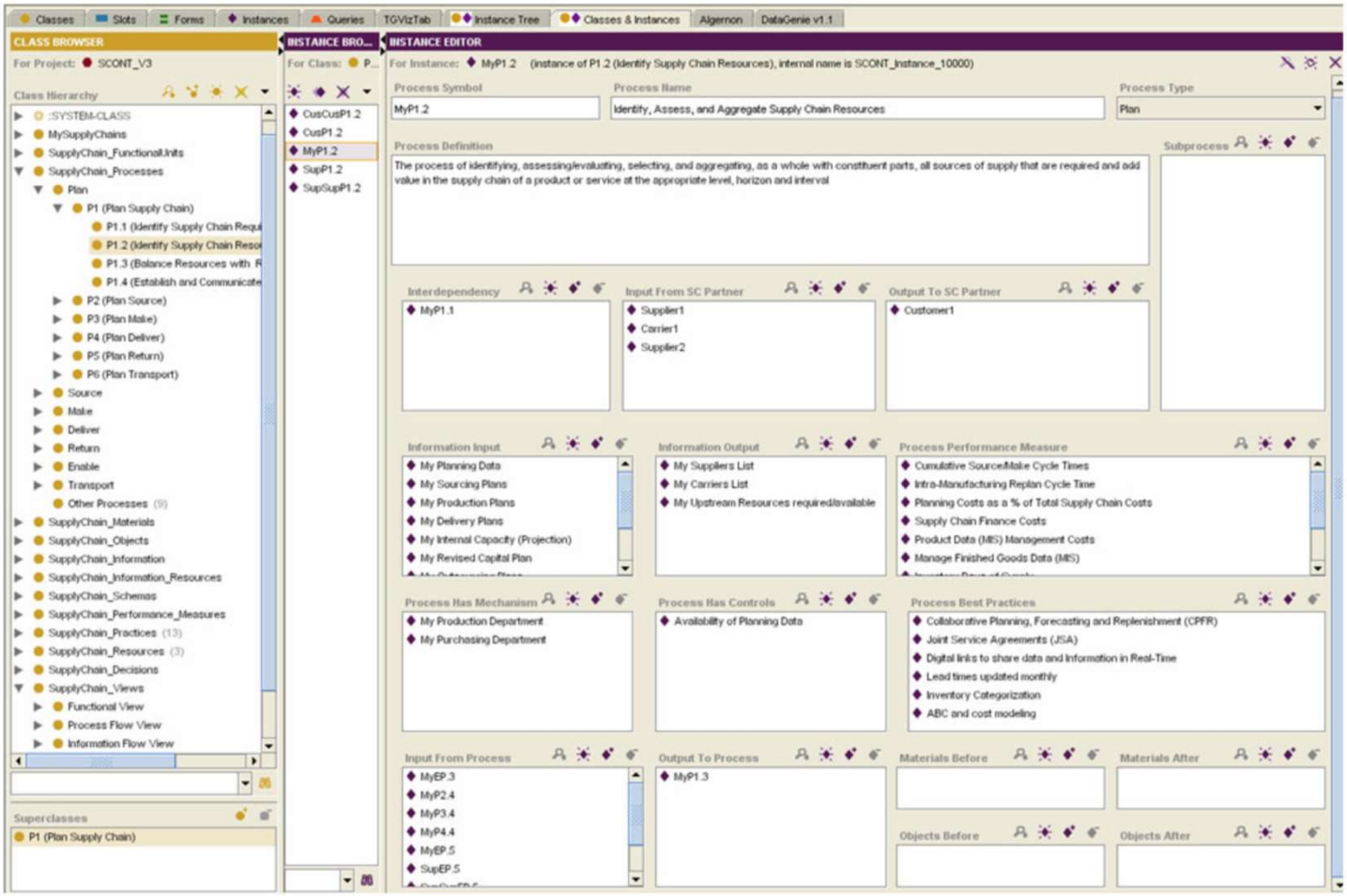
- Emissions
- Healthcare Problems
- Megacities
- Emergency logistics
- …

Selected trends in logistic simulations

Ontologies

Ontologies for supply chain models (2005)

In order to develop usable supply chain simulation models, the models should be feasibly applicable in the supply chain environment. Distributed simulation models have been used by several researchers, however, their complexity and usability hindered their continuation. In this paper, a new approach is proposed. The approach is based on Ontologies to integrate several supply chain views and models, which captures the required distributed knowledge to build simulation models.



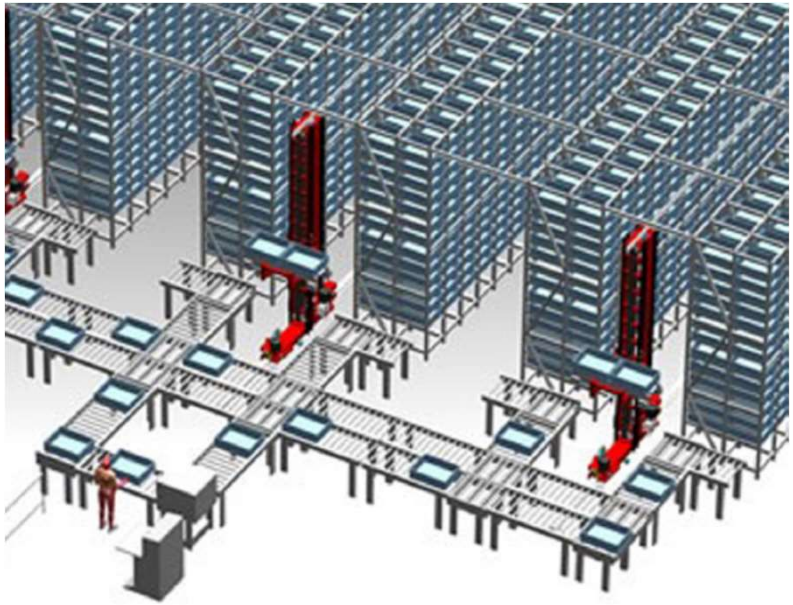
An ontology is a formally defined system of concepts and relations between these concepts.

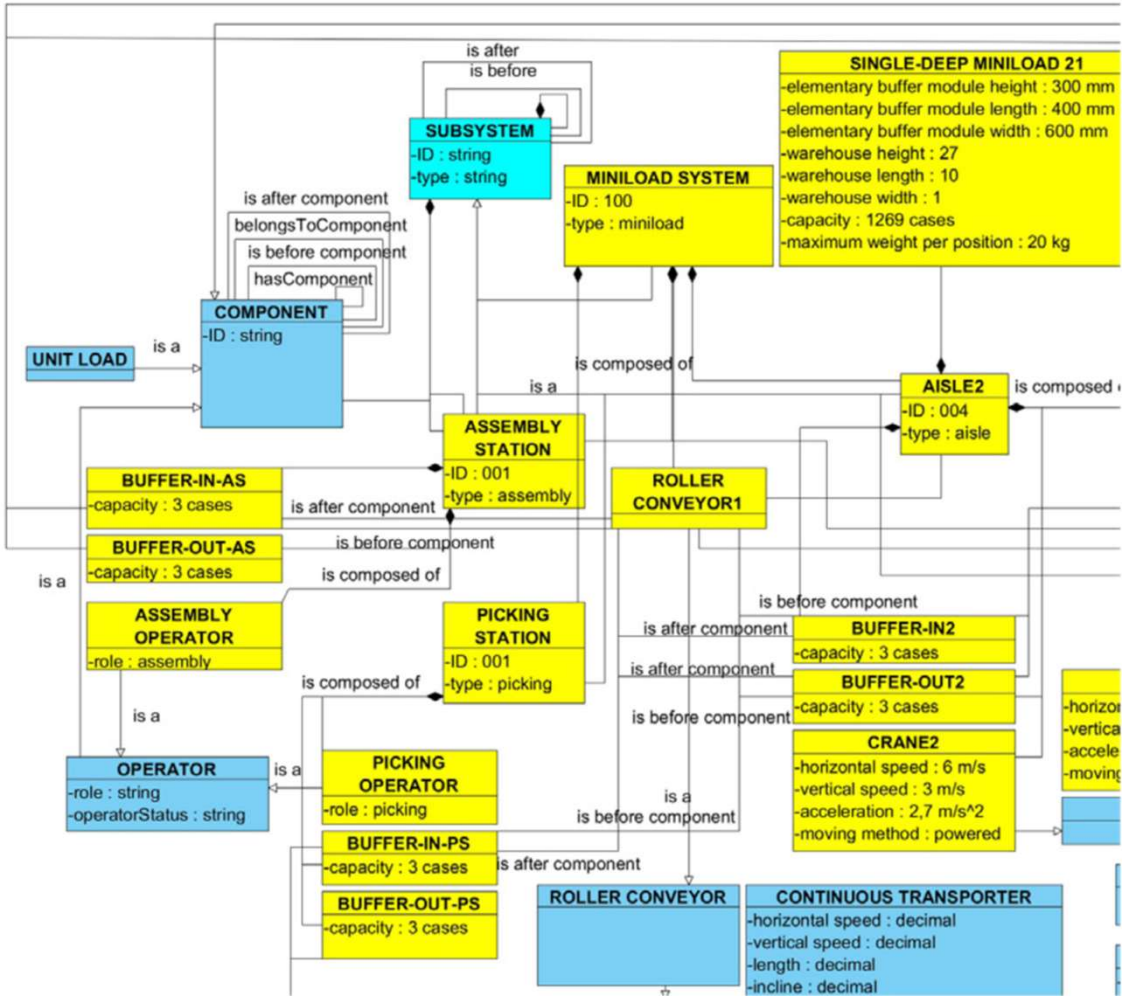
Selected trends in logistic simulations

Ontologies

Modelling internal logistics systems through ontologies (2017)

The paper presents the structure of the hierarchical relations within the examined internal logistics elements, namely Storage and Transporters, structuring them in a series of classes and sub-classes, suggesting also the relationships and the attributes to be considered to complete the modelling.

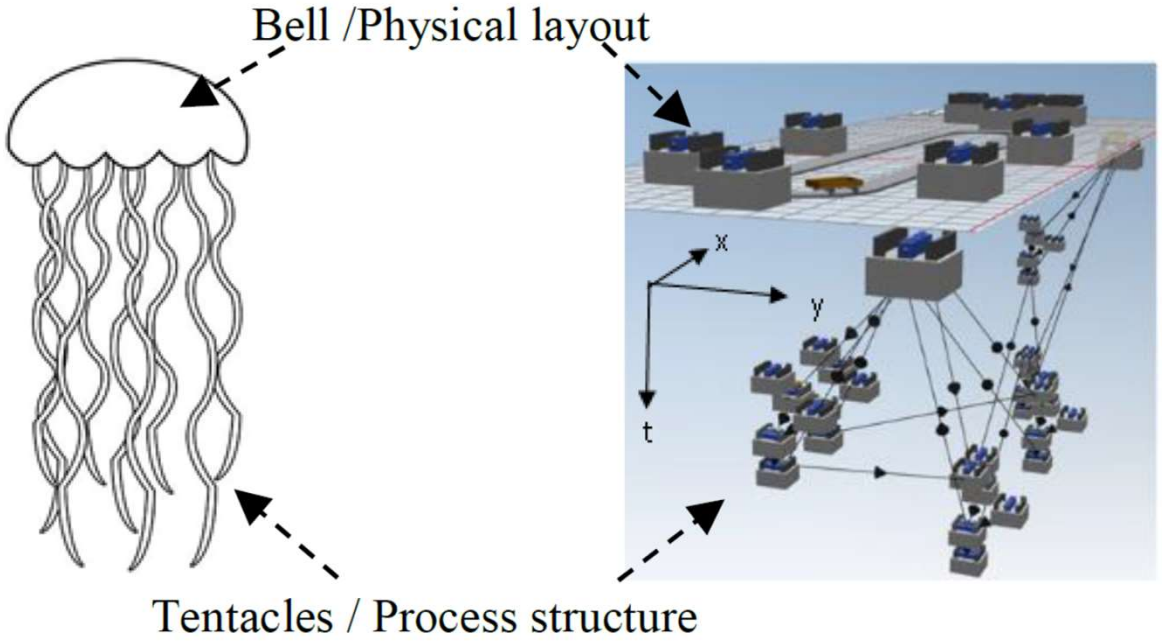


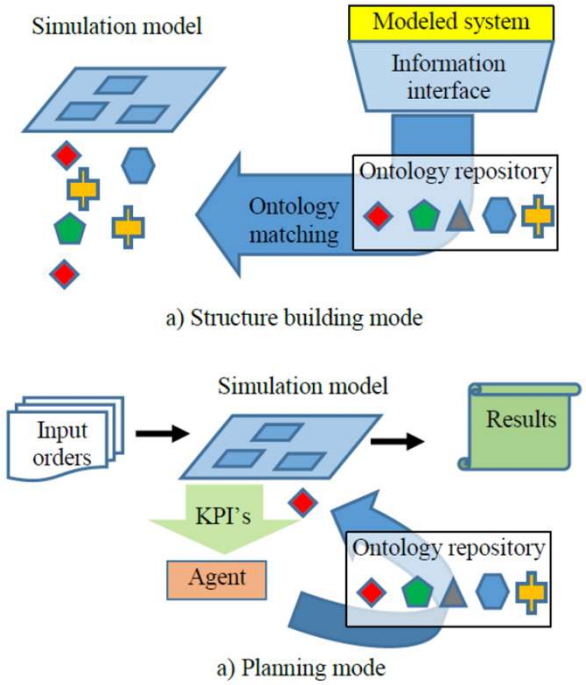


Selected trends in logistic simulations

Ontologies

Development of an Ontology-driven, Com-ponent Based Framework for the Implementation of Adaptiveness in a Jellyfish-type Simulation Model (2017)





Selected trends in logistic simulations

Serious games and in logistic simulations

CROSS-COLLABORATIVE SUPPLY CHAINS: SERIOUS GAMING VIA A CASE STUDY

Serious gaming has shown its contributions to make stakeholders aware of such phenomena in different domains than the logistics domain. In this paper we show the development of a serious game based on extensive case study material on different logistic service suppliers (LSP) in Europe.

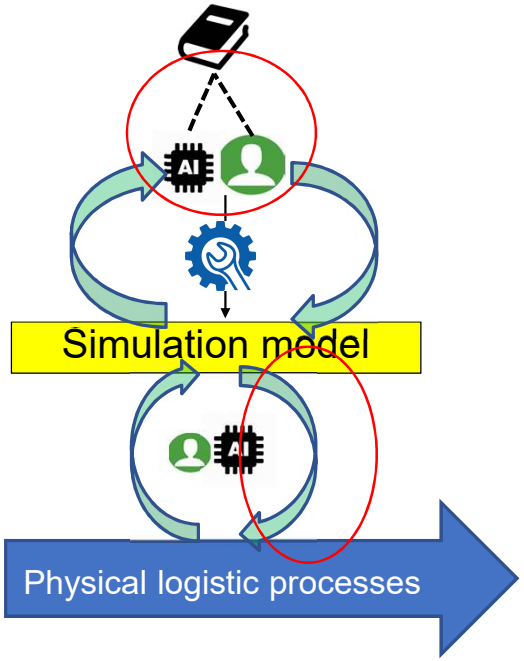
Selected trends in logistic simulations

Serious games and in logistic simulations

Simulation Game for Intelligent Production Logistics – The PuLL® Learning Factory (2016)

A new simulation game was developed with the learning focus on internal material flow, intelligently combined with Industry 4.0 components. The goal is to teach the adequate application of Industry 4.0 technology in production logistics.

Aims of research



Conclusion

This paper summarized main aspects of the simulations' application and evolution. Besides having surveyed currently apllied techniques, it has pointed out several future challanges. There has been a novel simulation-based framework concepted as well.

Thank you for your attention!