Introduction to Logistics Simulation
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Logistics Knowledge Management Group

- graduated in materials handling technology at the University of Technology in Magdeburg
- received a PhD in logistics from the University of Magdeburg
- holds a junior professorship in logistics knowledge management at the University of Magdeburg
- authored or co-authored
  - 2 books
  - 1 educational multimedia module on warehousing and a series of e-learning modules in logistics
  - more than 80 national or international journal publications, conference papers and presentations
- co-ordinates a network to provide new technologies for logistics education within the European Logistics Association (ELA)

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• has been part-time consultant in logistics simulation since 1991

• runs projects and is doing research on
  - problem solving and knowledge management in logistics
  - logistics simulation and planning
  - technology-based logistics learning
  - didactics of teaching logistics
  - logistics competence profiling and assessment

• teaches fields like
  - logistics modeling and simulation
  - logistics knowledge management
  - logistics process operation (control and management)

• guest-lectured in Scotland, Finland, Germany, Latvia

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Introduction to Logistics Simulation

- Logistics and simulation at the University of Magdeburg
- Discrete event simulation in logistics
- Simulation projects in logistics
- Lessons learned and recommendations
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Logistics and Simulation at the University of Magdeburg

- founded in 1993
- named after Otto-von-Guericke
- 9 Faculties
- about 200 professors
- 12,500 students
- 62 degree courses

Introduction to Logistics Simulation
• modeling, simulation and visualization as methods to support logistics planning and operation
  - special classes on basics in modeling and simulation
  - integrated transfer of basic knowledge and application competence on visualizing structures of logistics systems and processes
  - student projects to apply respective methods
modeling, simulation and visualization as methods to support logistics planning and operation

modeling, simulation and visualization as methods to enable illustrative and interactive logistics education

- integrating simulation models and animation sequences to illustrate complex cause-effect-chains (or even networks)
- offering possibilities for simulation-based experiments to directly see and understand influences and how to make use of them
The „Simulation Plate“ as physical model of a circulating chain conveyor system
Logistics simulation offers

- integration into conventional face-to-face teaching by providing
  - additional presentation material for lectures
  - computer exercises and lab sessions
  - student simulation projects

- integration into technology-based learning through self-developed applications

- integration into e-learning by use of professional simulation packages
LogEduGate: A Logistics e-Learning Environment

Introduction to Logistics Simulation

Logistik im Netz

Bei myLogEduGate anmelden

Logistik heute


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Discrete Event Simulation

• uses a model to:
  – chronologically reproduce real processes and systems realistically and accurately in detail
  – safely show processes and speed them up
  – repeat a certain process under identical conditions
  – modify systems and process as you like
  – visualize behavior by means of animation
Discrete Event Simulation

- uses a model
- is an approved method to support logistics planning and operation to:
  - test and evaluate logistics systems not yet existing for their functionality and performance
  - analyze and modify already existing logistics systems and processes with respect to changing loads or scenarios
  - look ahead in logistics process operation for trouble shooting
Discrete Event Simulation in the Lifecycle of a Logistics System

**Planning**
- simulating complex materials flow, control and warehousing systems, processes, staff allocation; testing parameters, analyzing performance, alternatives, bottle necks

**Implementation**
- simulating warm-up phases and step-by-step extensions; training systems; testing control algorithms and implementing them into the control station

**Operation**
- supervising systems and processes; supporting disposition of technical equipment and staff; analyzing "what-if" scenarios; training systems

**Process Level**
- incoming area
- stock of materials
- manufacturing and assembly
- stock of products
- outgoing area
- flow of materials and products (transportation system)
- permanent observation and control by simulation

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Typical Objectives of and Question to Logistics Simulation

• **general objectives:**
  - improving system performance with respect to more cost-effective solutions
  - supporting decisions in system’s design and selection of appropriate alternatives
  - checking hypothesis
  - approving planning results
  - illustrating complexity

• **typical questions:**
  - what-if analysis (How a system behaves with changing loads?)
  - what-to-do-to-achieve investigation (How set system parameters? How to improve control?)
  - minimize time in system or stock level, maximize service level or utilization

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There are Many Tools Available to Support Logistics Simulation

Simulation Software Tools
- Simulation Languages (e.g. GPSS)
- Simulation Packages (e.g. DOSIMIS-3, Arena, EM-Plant, Taylor-ED)
- Environments for Developing Simulation Packages

Closed Simulation Packages
- Simulation Packages adaptable with respect to modeling world
- Simulation Packages adaptable with respect to modeling world and functionality
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A simulation project aims at running experiments with a simulation model.

- **Pre-conditions:**
  - availability of sufficient simulation competence in the expected period of the project
  - availability of license and permission to use an appropriate simulation package

- **Procedure:**
  - preparation phase
  - simulation phase
  - interpretation phase
Procedure and phases of a logistics simulation project

**Introduction to Logistics Simulation**

**Simulation problem**

**Preparation phase**
- Analyzing the problem
- Model building
- Implementing the model
- Validating the model
- Planning experiments

**Simulation phase**
- Running experiments

**Interpretation phase**
- Understanding results
- Presenting results

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An Example: The Case of a Paper Storage

- incoming rolls
- preparation of rolls
- storage area operated by an automatic crane
- printing machines

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An Example:
The Case of a Paper Storage

**truck load:**
18 rolls (standing)

**belt conveyor**
capacity 18 rolls

**turn table:**
handing over rolls to transport cars

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An Example: The Case of a Paper Storage

451 storage places
2 automated cranes
(one as reserve only)
An Example:
The Case of a Paper Storage

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3 transport cars via linear guidance and turn tables automatic take-over of rolls
An Example: The Case of a Paper Storage

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An Example: The Case of a Paper Storage

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printing storage with 168 places
12 links to printing machines

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An Example: The Case of a Paper Storage

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4 printing machines with 3 roll carriers each
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Procedure and Phases of a Logistics Simulation Project

- **Simulation problem**
  - Preparation phase:
    - Analyzing the problem
    - Model building
    - Implementing the model
    - Validating the model
    - Planning experiments
  - Simulation phase:
    - Running experiments
  - Interpretation phase:
    - Understanding results
    - Presenting results
The Case of a Paper Storage: The Problem

• **setting:**
  - crane-operated floor storage of paper rolls

• **situation:**
  - the newly built, fully automated paper logistics system did not perform as expected/required
  - the automatic crane was said to be the bottleneck

• **tasks:**
  - analyze performance of all components and the system in total and identify bottlenecks
  - propose measures and activities to improve performance and give proof of their effects
The Case of a Paper Storage: Problem Analysis
The Case of a Paper Storage: Problem Analysis

Methods and tools:
Gantt chart (Excel), working cycle calculation, rough simulation (DOSIMIS-3)
The Case of a Paper Storage: Result of the Problem Analysis Step

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- idle cars
- supplied rolls
- unstored rolls
- unpacked rolls
- prepared rolls

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Procedure and Phases of a Logistics Simulation Project

- Preparation Phase:
  - Analyzing the problem
  - Model building
  - Implementing the model
  - Validating the model
  - Planning experiments

- Simulation Phase:
  - Running experiments

- Interpretation Phase:
  - Understanding results
  - Presenting results

Introduction to Logistics Simulation
The Case of a Paper Storage: The Model
Procedure and phases of a logistics simulation project

- **Simulation problem**
  - Preparation phase:
    - Analyzing the problem
    - Model building
    - Implementing the model
    - Validating the model
    - Planning experiments
  - Simulation phase:
    - Running experiments
  - Interpretation phase:
    - Understanding results
    - Presenting results

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Procedure and phases of a logistics simulation project

**Preparation Phase**
- Analyzing the problem
- Model building
- Implementing the model
- Validating the model
- Planning experiments

**Simulation Phase**
- Running experiments

**Interpretation Phase**
- Understanding results
- Presenting results

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If you need further assistance or have more questions, feel free to ask!
The Case of a Paper Storage: The Results

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Distribution of rolls' time in system
The Case of a Paper Storage: The Results

- Due to its design and technical parameters the available logistics system could never provide expected performance.
- The crane was not the bottleneck; the paper role preparation area was the problem.
- Proposed changes:
  - re-organization of flows in the preparation area: modified track for carriages
  - use of both cranes simultaneously: new control algorithm to avoid crashes
- Implementation of changes would tremendously improve performance; the system would be able to fulfill requirements.
- Simulation during the planning process would have avoided modification efforts.
The Case of a Paper Storage: The Results

- printing machines
- storage area operated by both automatic cranes
- preparation of roles
- incoming roles

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Procedure and phases of a logistics simulation project

- Preparation phase:
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- Simulation phase:
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- Interpretation phase:
  - Understanding results
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Lessons Learned and Recommendations

• Logistics simulation can support planning and operation of logistics systems and processes.
• Simulation needs to be integrated into planning and operation processes.
Typical scenario for using simulation in logistics

- **planning logistics system/process**
- **testing the planning result**
- **implementing the planning result**
- **doubt/uncertainty problems/failure**
- **need for simulation**
Logistics simulation need to be integrated into logistics planning.
Lessons Learned and Recommendations

- Logistics simulation can support planning and operation of logistics systems and processes.
- Simulation needs to be integrated into planning and operation processes.
- Simulation projects do not need to take long times or ask for high costs.
- The outcome of a simulation project strongly depends on the input data.
- Simulation projects need to be cooperative scenarios.

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Lessons Learned and Recommendations

- Reduce complexity to reduce efforts, e.g. by working with isolated parts of the system!
- But: Do not forget about possible relations between those system parts! (In case of heavy interrelations errors could appear.)
- Calculate before simulate!
- Do not trust stories about problems without cross-checking!