Digital design of intralogistics systems:
Flexible and agile solutions to short-cyclic fluctuations

Christoph Pott, Anike Murrenhoff, Moritz Wernecke and Philipp-Akira Bürger
Fraunhofer Institute for Material Flow and Logistics IML

In times of fast-paced, fluctuating and individual markets, intralogistics systems, such as warehouses, have to adapt to the resulting volatile performance demands dynamically. Hybrid systems, in which humans and machines work together efficiently and communicate in socio-technical networks, can be the answer to manage these high-frequency markets. Hybrid systems of the future need to adapt frequently and permanent change becomes the "new normal". A one-time planning of warehousing systems upon first installation becomes obsolete. This results in the question of how to design and implement processes for future logistics systems in an agile way in order to exploit the flexibility potential of hybrid services, which represent an interface between man, machine and organization. As part of the Innovation Lab Hybrid Services in Logistics in Dortmund, Germany, a research project funded by the German Federal Ministry of Education and Research, this research proposes a new concept for digital design of intralogistics systems that is meeting the requirements of a continuous, short-cycle adjustment following the Industry 4.0 development path.

INTRODUCTION

State of the Art
• Currently there is no universal solution for digital warehouse design
• Mainly level-based approaches to warehouse design can be found in the German research community
• The English-speaking literature shows a focus on mathematical optimization models for isolated problems
• Seldom the interaction between humans and machines or the operators experience and knowledge are (formally) involved in the design process

Research Questions
• RQ1: Which planning steps are necessary in digital design in order to be able to realize continuous and short-cycle adjustments in intralogistics systems?
• RQ2: What role do planner and operator play in hybrid systems and how can their knowledge be incorporated into intralogistics planning processes?

DIGITAL DESIGN

TRAINING

PARTICIPATIVE REALIZATION
Qualification
• New processes can be learned early in virtual reality
• The integration of new employees is decoupled from day-to-day operations
• Using gamification to increase motivation and accelerate the transfer of knowledge

Evaluation
• Perceptible visualization of the planning results
• Participative design of the working environment by employees
• Employee involvement increases acceptance of planning results

Evaluation
Virtualization

DIGITAL TWIN
Core Element
• Used for data collection and storage
• By using simulation, future states can also be predicted
• Central instance for further modules

Data Integration / Analysis
Monitoring System
• Monitors relevant key figures based on real-time data
• Determines the need for action in real time
• Can initiate new planning and rescheduling

PLANNING
Planning System
1. Requirements Definition
2. Service Flow Network
3. System Barriers
4. Technology and Resource Selection
5. Layout Design
6. Workplace Design

Restructuring

REFERENCES

• The concept of digital design makes planning of scalable intralogistics systems possible and meets the requirements of fast-paced individual markets
• The concept aims at designing and re-designing constantly changing systems and enabling employees to adapt to new systems more easily
• New technologies, e.g., Virtual Reality, offer new opportunities for evaluating systems and learning new processes
• The concept accelerates the acceptance and introduction of new technical solutions in the era of industry 4.0