Integrating Virtual Commissioning Based on High Level Emulation into Logistics Education

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Abstract

Increasing complexity is challenging logistics control systems development and commissioning. Emulation and virtual commissioning promise benefits over the classical approach, not only when used for lower level controls (e.g. PLC codes), but also for higher level controls such as material flow controls. This paper describes a general strategy to realize a virtual commissioning (based on VDI 3633), extended by the PDCA-approach known from quality management. A practical example shows how emulation and virtual commissioning can be integrated into and contribute to logistics education.

1. Introduction: The problem of growing complexity in logistics

With a growing number of variants and higher requirements towards service quality and schedule flexibility, the present approaches for production and logistics systems planning, commissioning and operations are challenged (Schenk, 2014). The increasing complexity is showing the weaknesses of classical centralized material flow controls and is impeding the development of these control systems (Bauernhansel, ten Hompel and Vogel-Heuser, 2014)

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(Bracht, Wenzel and Geckler, 2011). At the same time, the increasing digitalization of processes and the development and integration of innovative planning tools give the logistics planner the chance to face the future imminence.

1.1. The Digital Factory

The digitalized planning and operating systems are overwritten with the term “digital factory”, defined by VDI 4499 (2008) as “the generic term for a comprehensive network of digital models, methods and tools including simulation and 3D visualization […]. Its aim is the holistic planning, evaluation and ongoing improvement of all the main structures, processes and resources of the real factory in conjunction with the product.” Planning objects are plants and machineries, layouts, auxiliary operations, organizations, infrastructure and, of course, logistics. For all planning objects, the digital factory is aiming at economic improvement and technical excellence e.g. in the areas of product/process quality.

In the context of factory planning and operations, the areas of production process/facility planning, assembly and commissioning of production facilities, start-up management and serial production are examined in part 2 of VDI 4499 (2011). One of the main emphasis lies on virtual commissioning. It is rated as a suitable approach to shorten the physical plant start-up and to ensure the smooth transition into the serial production phase.

2. Virtual Commissioning

In the factory planning process, virtual commissioning is placed before the physical commissioning and can happen even before the physical system is installed. Wünsch (2007) defines it as “test of a control logic with a simulation model which is connected to a real or virtual control”. The literature (VDI, 2011), (Bergert et al., 2009) (Mewes and Wegener, 2009) is mentioning benefits of the virtual commissioning over the classical commissioning which are

- the discovery of design and planning errors before building the physical system,
- the shortening of the physical commissioning,
- the independency from the physical system’s location,
- the independency from the physical system’s installation time,
- the targeted simulation of failure scenarios,
- the faster execution of test programs and an increased number of test scenarios,
- the test of improvements during operation of the already existing physical system,
- and the simplified control development through direct feedback from the virtual system.

While all these bullet points show great advantages, the effort needed to implement virtual commissioning should be considered. It can be significantly reduced when combined with other methods from the digital factory, e.g. through the usage of digital planning models. Virtual commissioning will not completely replace the physical commissioning of a readily installed system as malfunctions due to installation errors cannot be detected (Mewes and Wegener, 2009).

2.1. Emulation: Technical Base for Virtual Commissioning

Closely connected with virtual commissioning is the term “emulation”. Emulation is a special case of simulation: a simulation model is used to replace a physical technical system. It is a typical tool to develop and commission control systems (Günthner and ten Hompel, 2010).

Auinger et al. (1999) and Follert and Trautmann (2006) classify emulation as one of four basically possible ways to analyze and evaluate system components. The following scheme shows the three applications relevant for logistics systems.

Use case one describes the classical commissioning where e.g. a conveying system is installed, connected to the (previously programmed) control and afterwards tested and commissioned. The second application is the usage of
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