

BASIC OVERVIEW ABOUT DIGITAL FACTORY AND VIRTUAL COMMISSIONING

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Keywords: digital factory, product lifecycle management, virtual commissioning, simulation

Abstract: The paper deals with PLM systems, which are using for management of products during their lifetime. For that it is necessary to have some special tool for it. Especially if we want to handle pre-production phase. The main philosophy is to get fully functional virtual system before it will be created in real production. This virtual system needs to be modeled according to requirements of product and its process of production. This concept is called virtual commissioning. Environment, which contains machines, robots, equipment, workers and products, needs to be simulated with all possible scenarios before it will be implemented to real production. The resolution of this idea is not only cost saving, but also shorter time of production planning.

1 Introduction

Digital factory is supported by special software solutions. One of the tools, which are useful for pre-production phase, is Process Simulate with its package named Virtual Commissioning. Process Simulate is a part of package named Tecnomatix, which is produced by Siemens company. Using this software package it's not a problem to create a realistic simulation, where we can test all production processes, their time, possible collisions, human ergonomics and many others. Higher level from this usage is to connect this software with real production. For that we use module Virtual Commissioning.

2 Process Simulate Virtual Commissioning

Process Simulate with its realistic 3D simulation of production processes have a one big advantage. Module Virtual Commissioning is used for connection between real production process and software Tecnomatix Process Simulate. It can easily create a realistic shadow of the production environment, test and debug PLC codes [1].

First of all, Process Simulate Virtual Commissioning looks like a classic simulation. It works with the same 3D.jt (.cojt) models, but those objects have the same parameters as the real machines, robots and human in the production process. It means the same size, shapes, color and of course behavior.

On the Figure 1 there is a basic schema of Virtual Commissioning environment. Engineer, especially software expert, creates production layout, which will be tested in the software simulation [2], [3]. After test and

debug there is a possibility to export PLC (programmable logic controller) program for real production system.

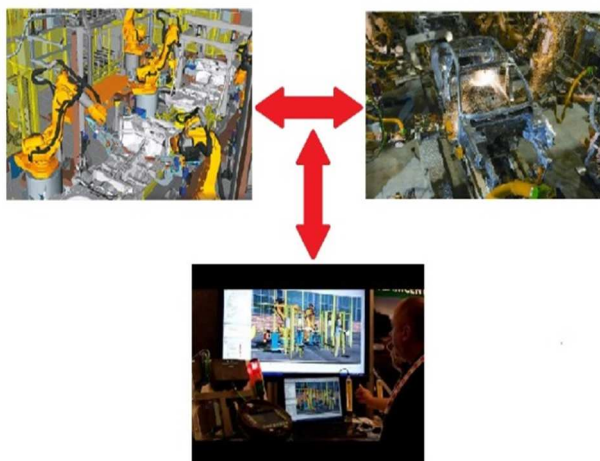


Figure 1 Virtual Commissioning environment

Figure 2 represents traditional concept of production planning. It starts with creating engineering and automation part of production line. So now we need to prepare all necessary objects which will be set up in the realization phase of the project [4], [5]. The whole layout with product will be tested and after time consuming debug it will be pushed to start the production. The same workflow is here for the changes too. If there is a change needed (e.g. new machine, new product, issue or collision

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on the production line), then we need to go step by step all over the procedure. Make a real model, test it, resolved issues and bottlenecks and finally start the production again [6], [7].

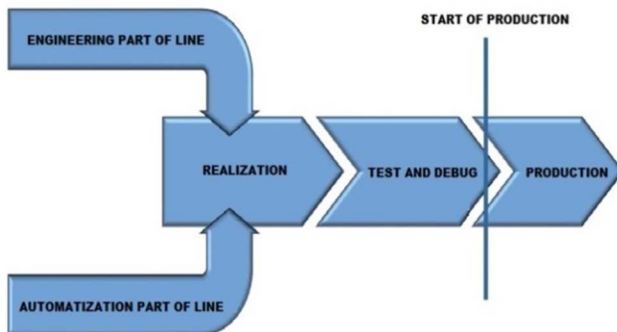


Figure 2 Traditional concept

Figure 3 represents innovative concept of Virtual Commissioning. Difference from the traditional concept is in the beginning of planning phase of project. After engineering and automatization part of line there is a Virtual Commissioning phase which includes virtual testing of production system. Virtual Commissioning consist of PLC programming, hardware configuration, material flow, logistics, collisions, machine's capacity, security. All that stuff is necessary for every production process, but if it is in the virtual environment, there is a chance to time and cost saving [8], [9].

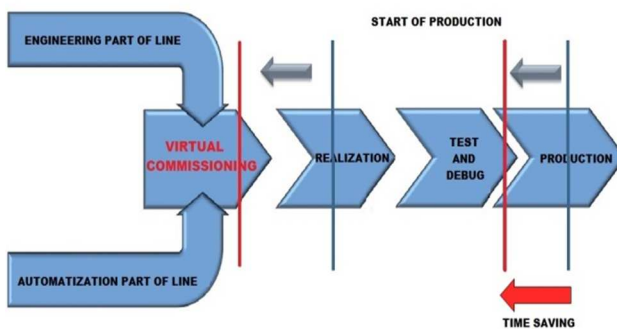


Figure 3 Innovative concept

3 Workflow of Virtual Commissioning

Process Simulate Virtual Commissioning (Figure has the following phases during the project creation:

1. Creation 3D models of all workplace's objects (models are in the .jt or .cojt format, designed in the NX software or downloaded from the producer of machine – ABB, KUKA, etc.).
2. New project in the software Process Simulate.

3. Library creation (Navigation tree), which consists of parts (product parts) and resources (machines, robots, human, etc.). Parts assignment to library.
4. Layout creation using imported 3D models.
5. Operation Tree – modeling of process structure (type of process, relationships between processes).
6. Welding operations – welding points assignment.
7. Robot controller:
 - a. default robot controller – included in the Process Simulate – robot movements corresponds to 80 % with real robot movements
 - b. customized controller settings – robot movements corresponds to 95 % with real robot movements - consist of RCS (Robot Controller Simulation) and OLP (Off Line Programming package). OLP package needs to be installed and RCS module needs to be downloaded for a specific robot
8. Robot program – program inventory – creating a new robot program or download default robot program where we can make a change according to process requirements.
9. Simulation can be:
 - a. time based simulation – predefined sequence of operations dictates the simulation of the process
 - b. event based simulation – line simulation mode – simulation based on events and signals
10. For Virtual Commissioning we need to use event based simulation.
11. Virtual Commissioning – need to create OPC connection – connection between PLC and Process Simulate.
12. Virtual Commissioning consist of PLC and logic blocks.
13. Virtual Commissioning works with 4 types of signal, and the most important (for Virtual Commissioning) are Resource Input Signal and Resource Output Signal, which give us signals about start or finish the operation. All signals can be shown and edited in the Signal Viewer window.
14. Each operation must have own default input signal, where we can generate output signal.
15. Sensors definition.
16. Logic blocks – represents relationships between input and output signals (e.g. if the signal change from 1 to 0, then 1st event will be executed).
17. Creating a connection between Process Simulate Virtual Commissioning and PLC through OPC server or SimbaBox.

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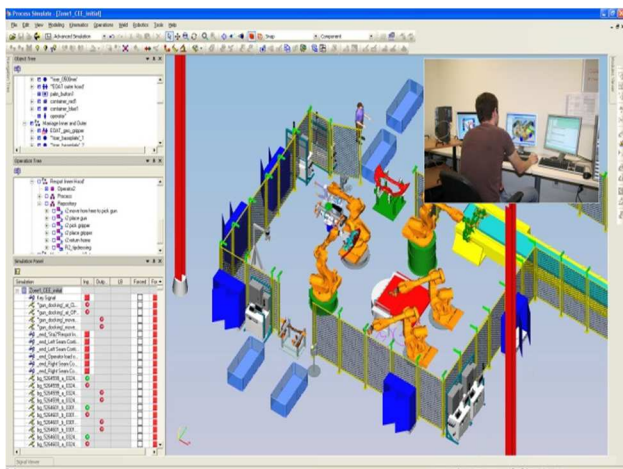


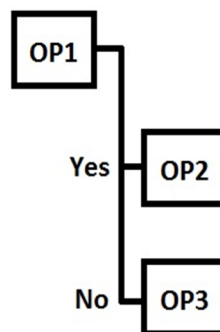
Figure 4 Process Simulate Virtual Commissioning

4 Event based simulation

The Event-Based Simulation module enables you to use Process Simulate to carry out the two stages of design on a single platform, reducing the time of on-site integration and the cost of changes. The Event-Based Simulation module provides a simulation environment that supports the design and verification of sophisticated production stations. The module can simulate production stations where a variety of robots, manufacturing resources, and control devices must function in full synchronization. Process Simulate's Event-Based Simulation module offers an approach that is much more accurate than conventional time-based (sequence) simulations, creating programs off line and an event-based and flow control simulation that enables you to simulate multiple robots and the surrounding devices in the production station [1], [10].

In event-based simulation, the logic of the process and the events that occur during the simulation determine the course of the simulation. The sequence of the operations is only one element of the complete logic definition. Because the events that occur during a simulation can vary, each simulation of the same process can be unique.

Event - based



Time - based

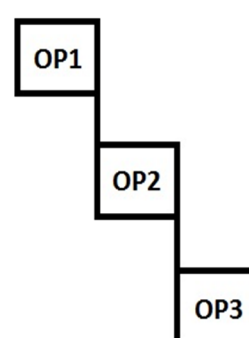


Figure 5 Event based simulation

Conclusion

Nowadays all automated systems in the manufacturing processes are handled by PLC programs. Software Tecnomatix Process Simulate with its module Virtual Commissioning we can create, test and debug PLC codes for that machines before it is implemented to real production environment. Those simulations include all movements, signals, material flow and safety parameters which have the same behavior as the real production system. By virtual testing we can detect and eliminate possible errors or bottlenecks, which can cause high financial issues in the future. By those simulations we can confirm that robots and other automated machines will work as expected, which bring up reducing of system startup time, or system change time.

Acknowledgement

This article was created by implementation of the grant project KEGA 4/2013 „Intensification of modeling in education of II. and III. degree in the field of study 05/02/52 Industrial Engineering“.

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Review process

Single-blind peer reviewed process by two reviewers.