

# PACKML AND ITS INTEGRATION INTO ABB ROBOT STUDIO FOR HOLONIC MANUFACTURING SYSTEM TESTING

**Tomas Benesl**

**Doctoral Degree Programme (2), FEEC BUT**

E-mail: xbenes23@stud.feec.vutbr.cz

Supervised by: Zdenek Bradac

E-mail: bradac@feec.vutbr.cz

**Abstract:** This paper describes the possibilities of using PackML standard in ABB Robot Studio for stimulating a holonic manufacturing systems. Using the creation of the functional and animated model in ABB Robot Studio, it is possible to implement PackML standards to this model. Using multiple models, the whole manufacturing process can be simulated, with the aim of testing and debugging a holonic manufacturing system control.

**Keywords:** PackML, ABB Robot Studio, holonic manufacturing systems, Industry 4.0, virtual manufacturing, holonic manufacturing systems

## 1 INTRODUCTION

Virtual commissioning is one pillar of the Industry 4.0. Real systems and situations can be simulated, tested and debugged before creating the real one. Regarding new approach of manufacturing management called holonic manufacturing system comes many questions about efficiency, possibilities of deadlock creations, reactions to partial system failure, etc.

To find out the answers to these questions, there is a need to create a functional simulation that might be used to simulate the behavior of a holonic manufacturing system.

There exist few software possibilities which can be used to simulate isolated manufacturing process or even the entire factory. One of this software is ABB Robot Studio. Besides it, Tecnomatix Process Simulate (Siemens), Delmia (Dassault Systems) are frequently used too.

Tecnomatix Process Simulate, which is available with academic license (Brno University of Technology - BUT), is very complex software, which can communicate with 3rd party software through OPC UA. However, it is difficult to get into motion custom created models of production cells or their parts. On the other hand, ABB Robot Studio can be used much better for getting into motion these custom models. Unfortunately, it does not support OPC UA. Academic license is available in university (BUT) too. The most complex is the DS Delmia, but it is not available for academic purposes.

With the idea of creating a test scenario (printing a part of a product and then composing it and exporting it), where production is managed automatically and decentralized (holonic systems [5]), there is a requirement to create a simulation and test environment that will support standard control structures and simulate the processes. Because of using custom parts of manufacturing processes, which need to be simulated the ABB Robot Studio has been selected.

## 2 HOLONIC MANUFACTURING SYSTEMS (HMS)

The holonic system can be described as a control system which is constructed by holons. Holon can be imagined as one single manufacturing cell or control system (PLC) with an HMI panel. Now-

days, due to the new Industry 4.0 paradigms and communication standards (including OPC UA), it is less difficult to create HMS. HMS is aimed to be used in discrete-type manufacturing processes.

Reliable and robust communication between individual holons is necessary for HMS because the production is not planned and controlled by supervised system (MES), but the whole manufacture is controlled by the holons itself. [5]

One of the features, which is crucial for every holon is a decision system or AI controlling its own behavior (e.g. decision when and how to manufacture the specific product, the need for the maintenance, etc.).

In the following text, I introduce one of the suitable standards for HMS process control – Packaging machine language (PackML).

## **2.1 PACKML**

Packaging machine language is standard, which can be helpful to collect data, monitor production lines and for data distribution. PackML defines three basic entities:

- terminology,
- state model and
- tags.

The terminology is similar to ISA-88 terminology (S88 at has been inferred from PackML).

The entire machine is called a unit. Every unit consists of one or several equipment modules representing filling, feeding, outlet subsystem, etc. Every equipment module has one or several actuators. These actuators are controlled by a control module. Moreover, every equipment module has its actual state, described by the state model (see Picture 1). Equipment module state can be changed by state commands (e.g. operating mode - automatic production, manual, cleaning, maintenance – can be selected, etc.). [4]

Tags are divided into three categories: states, commands and admin tags. Commands can change states and admin tags are used for analysis. This means if some stop or error event appears it is written into admin tag the reason for this event. Also can be used for production time, progress, stoppage time, etc. [4]

Because of PackML and OPC UA, it can be seen a status of every machine in the factory that means the product can choose which manufacturing cell wants to use, or start negotiation with several cells and after that choose the best based on the selected criterion.

## **3 VIRTUAL HOLONIC MANUFACTURING**

Because of greater demands to manufacturing and product customizable and scalability, it is harder to create a factory in the standard way – controlled by MES, because reconfiguration and customizable the whole production can be expensive and time difficult.

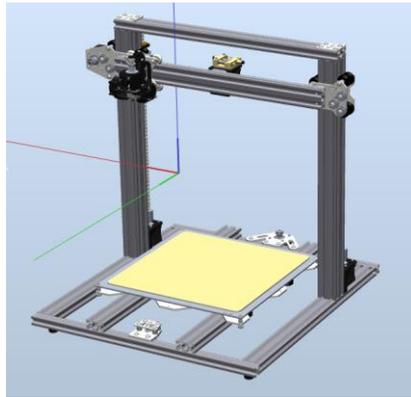
For this demands, it is perfectly suited the idea of HMS, where every production cell offering services and if the product finds suitable production cell to its creation, it can be planned the production of this product without the need of reconfiguration of a factory. [3]

It can be a very complex problem to create HMS fully operational in the real system or factory without previous testing and debugging. For this purposes, a virtual manufacturing process with several production cell, supermarkets, and robots was created in ABB Robot Studio.

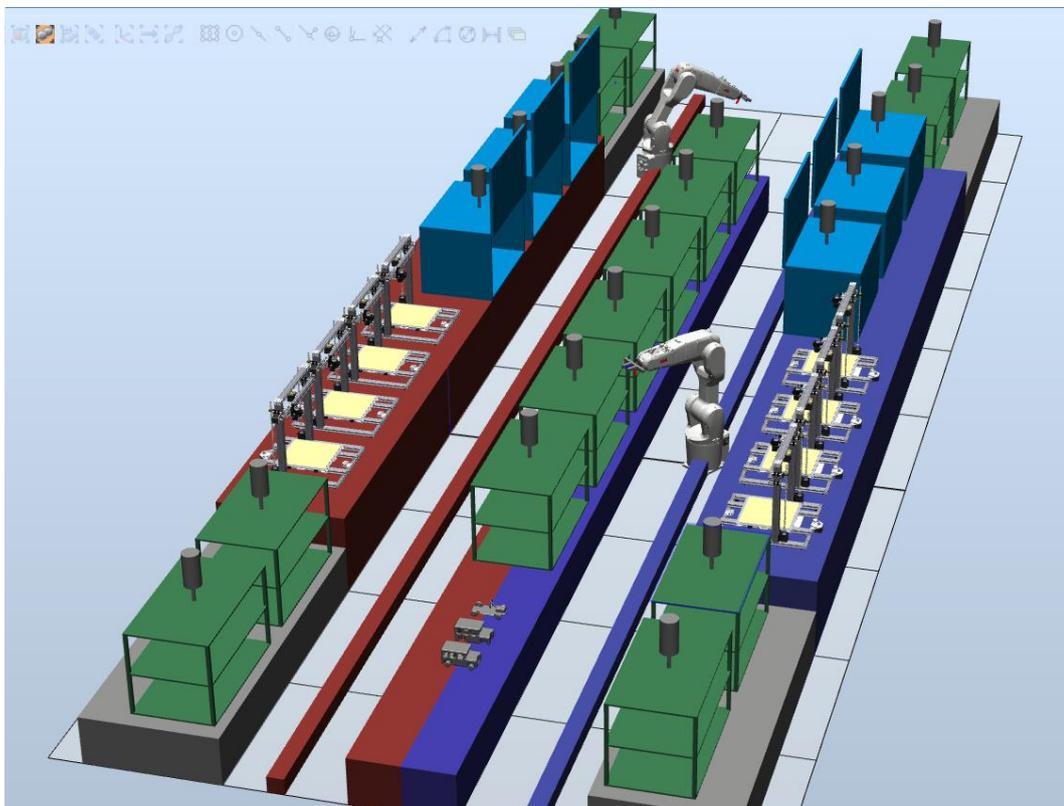
### **3.1 ABB ROBOT STUDIO**

ABB Robot Studio (RS) is primarily determined to simulate ABB robots and create programs for a real use. There can be tested collision paths, working space, etc. Next possibility of RS is to import





Picture 2: ABB Robot Studio 3D printer model



Picture 3: ABB Robot studio HMS simulation

RS does not support OPC UA for communication with custom models, only with robot controllers, but there is a component called RSapi, which can be added into a project and causes that the simulation of RS can be controlled by API from another software. The external software is creating communication interface so that every production cell has its own OPC UA server and client to communicate with others.

#### 4 CONCLUSION

HMS simulation was created in RS, which can be used to create and program software to control every production cell (service provider) with the special requirements that are put on HMS and can be really used in real manufacturing. Each intelligent component has a PackML state machine implemented in it. Using commands from RSapi, it is possible to change states and thus to perform

the simulated process (printing object, folding in assembly box). With RSapi component every production cell can communicate with OPC UA, which is standardized for Industry 4.0 communication. This is the first step before creating data structures, communication models, decision and optimizing algorithms, etc.

The biggest advantage of this approach is the almost identical structure of how it works in the industry. It is, therefore, possible to debug algorithms so that they can later be deployed on a real application. Another advantage is that machine failure, any situation can simply be simulated and then the behavior of the entire system can be observed.

There is a need to be created a universal data structure for a service provider (SP) and service requester (SR) and describe communication and negotiation between SR and SP. Sometimes SP can become SR e.g. in a case when production cell needs to change tool, requires maintenance need a material, etc. Actually, all these actions are solved by a superior system like MES or operator. The superior system is a single point of failure and the expensive and time difficult reconfiguration are two biggest disadvantages, which can be solved by HMS.

But with HMS comes a lot of questions of manufacturing effectiveness, deadlock possibilities, communication difficulty, cyber – security, etc. Without future testing of HMS algorithms cannot be said that this system can work, but with virtual simulation platform is easier to construct testing scenarios, collect data a see possibilities or potential hazards.

The future work is to simulate fully working HMS, where is the production controlled by product and production is much customer oriented than in these days. With fully working simulation it is possible to present it to a factory owner and demonstrate the advantages of this solution.

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