Efficient Implementation Of Network-enabled Devices Into Industrial Environment

Implementation criterias and practical business processes for integrating intelligent network-enabled devices

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***Abstract* - This paper introduces, at early-stage of research, a concept for implementing network-enabled devices (NETDEV) into industrial environment for the phase of ramp-up production. Based on a drafted standard procedure, beside technical aspects, economic ones shall be considered before projecting realization, to ensure cost-effectiveness.**

Keywords - Network-enabled device; Efficient Implementation; Evaluation procedure; Ramp-up phase; Economic viability

I. Introduction

There is no denying that the manufacturing industry is facing a transition towards a completely interrelated knowledge-based business [1]. Intelligent machines, which are able to communicate and are aware of their own status, are becoming indispensable in order to assure and enlarge the competitive advantage and to help the process towards a flexible and sustainable production. This paper describes the business process and respective criteria for on-hand incorporation of NETDEVs into the production line.

A NETDEV is an acronym for Network-Enabled-Devices. These can be considered as logical entities, which encapsulate a device, as equipment or part of equipment, a single sensor or network of sensors or a combination of these components. In general, NETDEVs are able to incorporate build-in intelligence based on a set of models. These models enable the production device to expedite ramp-up process, find optimal process parameters, and support for maintenance and quality assessment. The concept and the NETDEV itself has been developed within the EU-funded research project I-RAMP³ [4], whose goal is the creation of novel solutions for enhancing competitiveness of European industry sector by creating a concept for fast and optimized ramp-up and operation of production lines.

For the majority of companies creating an added value with operating machines, the incorporation of network-enabled devices is projected to be advantageous. However, prior to the implementation into active production lines, it has to be considered that implementations like these require an inter-divisional composition of all business processes, considering evaluation, planning, and change management. For every company, the de facto person in charge of production output and production costs, e.g., Chief-Technical-Officer (CTO), has to analyze the current state-of-the-art of the manufacturing facility and, based on this, to fathom if the advantages of an implementation prevail.

In Section 2, an overview for a business process for implementing NETDEVs is being provided. Section 3 describes the target definition, as first phase, in more detail, followed by a conclusion in Section 4.

II. General Approach

The process of implementation should go along with existing planning standards, such as the planning process according to VDI 5200-1 “Factory planning” [2] (Figure 1) or other approaches aiming to execute green-field installations, expansions, or re-structuring of existing production facilities. As reference for a planning structure, this instruction was chosen as it is considered as a common planning standard to decision makers within the industrial environment.

Figure 1.Factory planning process according VDI 5200-1 [2]

To ideally gain SMART (“Specific, Measurable, Accepted, Realistic, and Timely”) targets the first phase aims to set the goals for the future project. In the use case of implementing NETDEVs into an existing production line, decisions have to be made on which equipment is technically applicable with the upgrade using NETDEVs. Also, its economic viability has to be reviewed before a final definition on the scope can be determined. This paper is focusing on the process of this phase, which will be examined in detail in the following sections.

After fixing the final definition of the scope, structured requirement analysis, considering framework conditions, use cases and scenarios, roles will follow in a second step. The design of the NETDEV architecture would follow according

 ISBN: 978-1-61208-437-4

to standardized, but customized to the requirements of NETDEV implementation, development methodologies.

In the phase of implementation, acceptance procedures and standardized methods for change management could be applicable. This would go along with appropriate training of personnel, manual working instructions, and documentations, which are based on the results of the requirement analysis and following phases.

III. PHASE I: TARGET DEFINITION

Starting with target definition, it becomes clear that a differentiation has to be made which production machines should be equipped with additional communication and intelligence capabilities, such as the NETDEV.

This analysis is necessary due to the fact that, despite its advantageous aspects, the installation requires human resources for initial installation, integration and customization of the NETDEV for all considered production equipment. Further on, maintenance efforts also would cause additional costs during the future life-cycle of the equipment. Potential realization risks may cause unscheduled downtimes of the machine and would possibly lead to idle periods at process equipment within the value chain.

As a pre-condition, prior to the implementation, an analysis of technical features of the production equipment is indispensable. Giving an example, connecting the equipment, which would have no communication requirements, would also not underlie any flexibility aspects, such as for exchange of tools or changing process recipes, and would not consider any deviating manual working instructions for operators. Applying a NETDEV for this use case should be questioned. Coming along with the fact that the production equipment is an easily exchangeable, multifold redundant and not cost intensive tool, some analysis would be appropriate to evaluate its economically viability. Putting it into a nutshell: a ramp-up exists, in various natures and scopes, for a wide range of production equipment and components. And every ramp-up time causes unused capacities and by that potentially negative impact on life-cycle-costs.

An additional aspect could be its projected life-cycle. Given that installing a NETDEV with equipment which will last for several years makes sense, does not automatically imply that it is profitable to integrate a tool which is definitely worn after a couple of days. (Using a NETDEV to prolong this period of time would be an additional argument for installing.)

Besides technical conditions, additional framework requirements could have an impact on the decision to potentially install a NETDEV. Based on the fact that a certain knowledge and education is necessary in order to handle higher complexity could possibly hamper the installation in individual cases.

These arguments make clear that it is not useful to equip every production machine with a NETDEV and by that to provide additional intelligence and communication abilities to it. Even if arguments would support an installation, it is important to identify at what level, and respectively which parts of the equipment should be integrated**.**

It is worth mentioning that NETDEV implementations, triggered by equipment suppliers, in detail would underlie different rules. However, in order to be successful on the market it is required to satisfy customers' requirements.

Despite potential disadvantages and risks, by nature, a range of positive aspects also have an impact on the definition of the scope of integration of NETDEVs.

Additional intelligence and communication skills provide a range of advantages. Due to the bulk of known benefits, in the context of this paper only an extract is be provided.

An expedite integration of the production equipment with controlling, Manufacturing-Execution-System (MES), sensors and actors, and other peripherals enables a fast integration when ramping-up, either at initial installation or after a product exchange or an unscheduled downtime.

An instant access to data and information can be achieved. Also additional analyzes by applying "Big-Data", respectively Data-Mining methodologies can be executed. Knowledge can be used to identifying existing or potential problems, and by that may allow identifying potentials for further optimization on the production system.

All of these advantages, by nature, could be executed without any intelligent network-enabled system. However, the efforts to detect, analyze, evaluate, and provide suggestions for optimizations could be significantly higher than with applying a NETDEV or other net-enabled devices providing similar features.

IV. CONCLUSION

The remarkable progress in the field of intelligent production inspired the authors to do research on how new technologies, like the NETDEV, could efficiently be transferred into industrial applications. By applying standardized implementation processes, combined with existing technical and economic planning methodologies, ramp-up phases can be shortened [3]. Implementing a more complex system, like a NETDEV well planned approaches become even more relevant in order to gain significant synergies applying NETDEVs.

ACKNOWLEDGMENT

The authors would like to address special thanks, supporting the progress on this topic to Flavio González (Fraunhofer IPA), Norbert Link (Hochschule Karlsruhe - Technik und Wirtschaft), and Patricia Wolny (Steinbeis-Europa-Zentrum) for their creative ideas and supportive contribution.

REFERENCES

[1] Bauernhansl, ten Hompel, Vogel-Heuser; Industrie 4.0 in Produktion, Automatisierung und Logistik, p.14, 2014 (in German)

[2] VDI 5200, Part 1, February 2011

[3] Bruns; Organisation des Anlaufmanagements; p.225; 2010 (in German)

[4] www.i-ramp3.eu [last accessed September 2015]