Chapter 21
Making IoT Run:
Opportunities and Challenges for Manufacturing Companies

Peter Schott
University Erlangen-Nuremberg, Germany

Torben Schaft
University Erlangen-Nuremberg, Germany

Stefan Thomas
REHAU AG + Co., Germany

Freimut Bodendorf
University Erlangen-Nuremberg, Germany

ABSTRACT

This article describes how today's manufacturing environments are characterized by an increasing demand for individual products and constantly more product variants. Concomitant, developments in the fields of IT, robotics and artificial intelligence allow the realization of smart systems, which means networked, self-learning, self-regulating and versatile production systems to control this complexity. These developments are referred to as industrial IoT that is acknowledged as "next big thing" in production. Firms face the challenge of lacking guidelines for implementing IoT solutions. Neither the technological prerequisites nor generally applicable procedures for realizing an appropriate technological maturity level of the system-to-be exist. Addressing this deficit, a framework is introduced which systematically implements IoT within manufacturing. The framework presents a guideline for the establishment of structural system understanding, the determination of the target system's technological maturity level from a customer's perspective and, building on this, design implications for smart manufacturing.

DOI: 10.4018/978-1-5225-9866-4.ch021

1. INTRODUCTION

The growing individualized demand for customized products leads to shortened product lifecycles and rising product and variant diversity (Bussmann, 2013). Since the beginning of this millennium, the product diversity across all industries increased by more than 100% (RBSC, 2012). Simultaneously, during the same period product life cycles shortened by an average of 25%, in the consumer goods sector even by over 50% (RBSC, 2012). The quick response to fluctuations in demand by increased flexibility and efficiency in production is therefore an important factor for manufacturing companies (RBSC, 2012; Bussmann, 2013). Hence, industrial production faces an emerging need for operational excellence, e.g., by lot size reduction, shortening lead times and the efficient use of production resources (Horx, 2011; Riedel and Voigt, 2013). Steadily growing complexity within production systems is the consequence of these developments (Ashby, 1970; Bauernhansl, 2014; Seifert et al., 2013). In literature and practice, mastering this complexity is recognized and described as a key success factor for companies (Kirchhof, 2003; Schuh and Kamper, n.d.). In this context, intelligent IT networking plays an essential role to control this complexity (Heinrich et al., 2015) and is referred to as (industrial) Internet of Things (IoT). IoT describes the networking of intelligent products and production resources and the inferable, data-driven implications to improve efficiency and productivity. In manufacturing IoT combines physical (e.g. mechanical elements), intelligent (e.g. embedded software systems) and intangible mediation (e.g. network protocols) components (Ziegler and Römhild, 2015). Consequently, the International Telecommunication Union (ITU) defines IoT as "a global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies" (ITU, 2012).

The real-time availability of all relevant information by the digital networking across the value chain forms the basis for the optimization of production systems in terms of cost, availability and resource efficiency (Plattform Industrie 4.0). Industrial IoT provides a practicable solution space for optimizing production systems by means of information and communication technologies (ICT) (Wortmann and Fluechter, 2015). In order to exploit the associated potentials, solutions must be geared to the actual market requirements and specific customer expectations (Nagalingam and Lin, 2008). This is particularly evident in the light of the limitations of Computer Integrated Manufacturing (CIM) in the 80s and early 90s of the 20th century. CIM was a promising approach for computer-based integration of production technology (e.g., CAD, CAM) and procedural functions (e.g., planning, control) (Schneider, 1992). CIM reached its limits because it was geared to the technically possible solutions, not those solutions demanded by the market ("over-engineering").

So, in some cases the introduction of an assistance system in production should be preferred to an autonomous, self-governing system (Soder, 2014) in order to achieve the required level of performance from a customer perspective.

In this regard, a general understanding for the realization of "intelligence" through IoT within manufacturing does not exist (BMBF, 2015), neither regarding

- the integration of IT and production (horizontal and vertical) depending on the specific application context
- nor the determination of the required maturity level of the solutions to be implemented (and thus the degree of "intelligence" of a production system).