A European Manufacturing Platform for Zero-Defects

Stuart Campbell[a], Santiago Cáceres[b], Gerardo Pagalday[c], Raul Poler[d] and Ricardo Jardim-Gonçalves[e]

[a] *Information Catalyst for Enterprise Limited, C/O Bb, Winnington Avenue, Northwich, CW5 4EE, UK*
[b] *Instituto Tecnológico de Informática, Camino de Vera s/n, Valencia, 46022, Spain*
[c] *kerlan Technology Research Centre, Pº J. M. Arizmendiarrieta 2, Arrasate, Gipuzkoa, 20500, Spain*
[d] *CIGIP, Universitat Politecnica de Valencia, Calle Alarcón 1, Alcoy, 03801, Spain*
[e] *UNINOVA, Universidade Nova de Lisboa, Monte de Caparica, Caparica, 2829-516, Portugal*

Abstract

This paper presents the European Manufacturing Platform for Zero-Defects build in the frame of the H2020 project entitled "Zero Defect Manufacturing Platform" (ZDMP). The ZDMP project combines state of the art technological approaches based on commercial grade standard or open-source or previous-project software with an innovative integration concept based on proven and integrating technologies. It provides Process and Product Quality support on top of a platform layer. These all can utilize ZDMP core services which can also be used to build ZD Apps which are placed on the ZD Marketplace.

Keywords 1

Zero Defects, Manufacturing Platform, Process Quality, Product Quality, Apps, Marketplace

1. Introduction

In the last five years, many industrial production entities in Europe have started strategic work towards a digital transformation into the fourth industrial revolution termed Industry 4.0. The concept of zero-defects in the management of quality is one of the main benefits deriving from the implementation of Industry 4.0, both in the digitalization of production processes and digitalization of the product quality [1].

To remain competitive and keep its leading manufacturing position, European industry is required to produce high quality products at a low cost, in the most efficient way. Today, manufacturing industry is undergoing a substantial transformation due to the proliferation of new digital and ICT solutions, which are applied along the production process chain and are helping to make production more efficient, as in the case of smart factories. The goal of the ZDMP Project is to develop and establish a digital platform for connected smart factories, allowing to achieve excellence in manufacturing through zero-defect processes and zero-defect products.

ZDMP aims at providing such an extendable platform for supporting factories with a high interoperability level, to cope with the concept of connected factories to reach the goal of zero-defect production. In this context, ZDMP will allow end-users to connect their systems (i.e. shop-floor and Enterprise Resource Planning systems) to benefit from the features of the platform. These benefits include product and production quality assurance amongst others. For this, the platform provides the tools to allow following each step of production, using data acquisition to automatically determine the functioning of each step regarding the quality of the process and product. With this, it is possible to follow production order status and optimize the overall processes regarding time constraints and product quality, achieving the zero defects.

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EMAIL: stuart.campbell@informationcatalyst.com (S. Campbell); scaceres@iti.es (S. Cáceres); gpagalday@ikerlan.es (G. Pagalday); rpoler@cigip.upv.es (R. Poler); rg@uninova.pt (R. Jardim-Gonçalves)
ORCID: 0000-0002-0384-2620 (S. Campbell); 0000-0002-3209-0034 (S. Cáceres); 0000-0001-5593-4730 (G. Pagalday); 0000-0003-4475-6371 (R. Poler); 0000-0002-3703-6854 (R. Jardim-Gonçalves)
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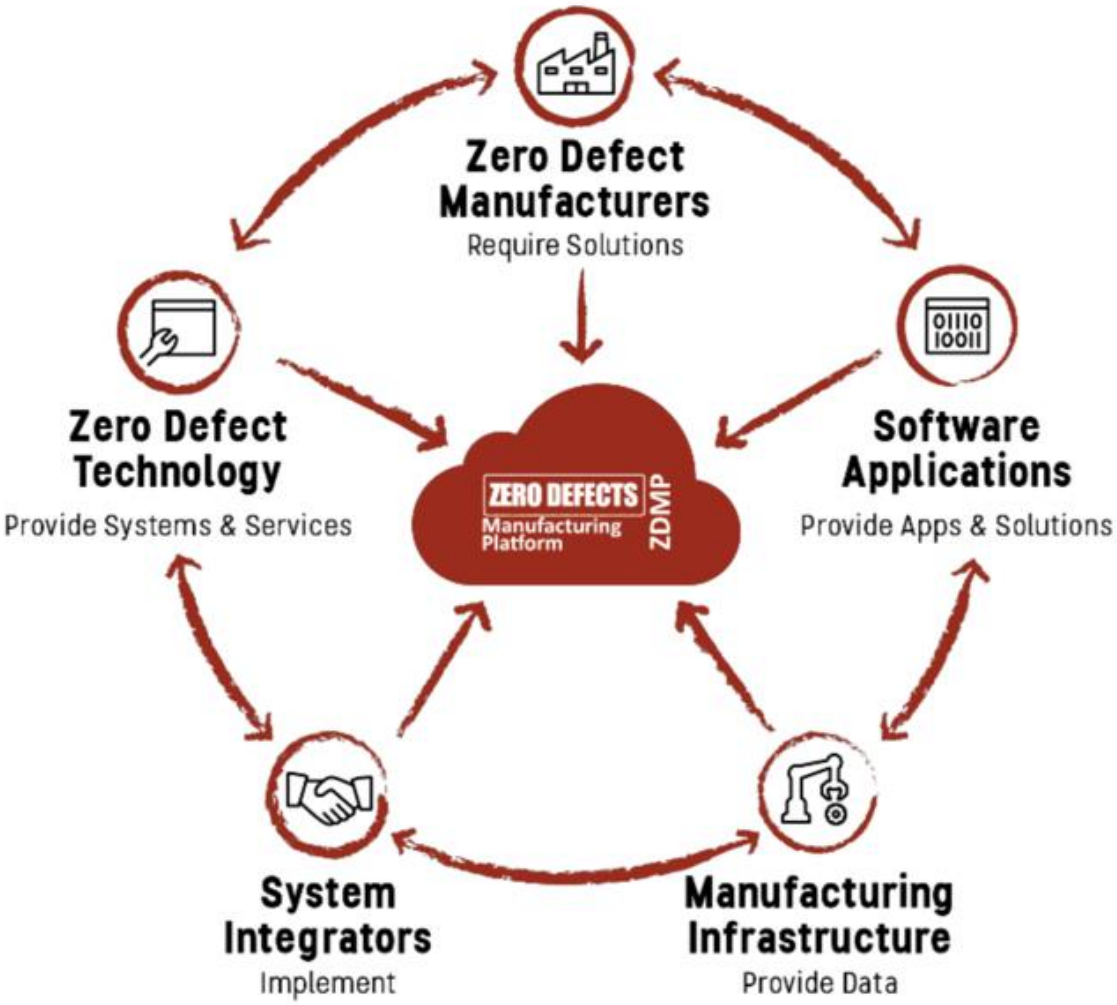

Figure 1: The ZDMP Stakeholders

2. The Challenge

Based on the Industry 4.0 (I4.0) new paradigm, companies must embrace new technological infrastructure which they expect to be easy-to-implement for their business, and easy-to-implement with other businesses across all their machines and systems. They then expect it to deliver back to the business in terms of a good return-on-investment. The implementation of I4.0 eases the digitalisation of production process quality and the digitization of product quality collectively referred to as "zero-defects" manufacturing (ZDM). Vice-versa, ZDM is a key driver for I4.0 implementation and infrastructure.

The infrastructure can be a digital manufacturing platform that provides the ability to connect various parts of the manufacturing lifecycle. It will use digital data to support the use of information for intelligent automation and smarter and more efficient decisions. Within the context of the ZDMP project, such a digital manufacturing platform has features orientated to ZDM and facilitated by the ZDMP consortium. The goal is functionality which is compliant with zero-defect needs; e.g. short response times, quick data transfer, security, infrastructure suitable for the access of different stakeholders, etc. Such features include components for data analysis, image processing, learning algorithms, cloud storage etc.

3. The Concept

The concept of ZDMP can be simplified to a feedback and control system found in areas ranging from human/autonomous driving through to electronics. Steering the system will be the ZDMP Applications (ZDMP Apps or zApps) composed using the projects' SDK and different components [2]. Broadly these Apps receive (and present/actuate) information from sensors/APIs and then process the data [3]. Influencing this are material flaws and process error as well as errors which create product/process defects. This data is processed through Process and Product Analytics Services which in turn feeds back to the Apps to complete the cycle, using smart systems and reiterating until the system is optimised and Zero-Defect Product/Process is achieved. ZDMP is thus a suite of components that deploys and enables a zero-defects ecosystem: i) To build applications that monitor, manage, and control connected devices; ii) To collect and analyse data from connected devices; iii) To predict defects and enable their prevention; iv) To manage interconnectivity from device/sensors, to machines, to factories, to partners; v) To offer core API services to facilitate the use of software applications; vi) To allow interoperability with 3rd party systems/services and other platforms; vii) To automate and provide services for an intelligent zero-defects ecosystem; viii) To enable secure connectivity and privacy between devices and throughout the platform.

In addition, it is important that several non-functional elements are met:

- Relative dependence from the domain of application (i.e. it will work beyond the domains of the ZDMP pilots – e.g. in the process industry or food production)
- Sustainability of not just technology but the business model in terms of commerciality (i.e. it should, for example, be commercially viable and practically implementable)
- Ensuring, where need, data privacy/sharing paradigms especially in a multi-partner Zero Defect scenario

The Zero-Defects Manufacturing Platform exists independently between the hardware and the application layers of the technology stack. The ideal platform will integrate with any connected device and any partner and blends them in with their devices, applications, exposed services, and enables the implementation of features and functions.

Establishing a complete system for such Industry 4.0 solutions is a huge undertaking for even the most resourceful of companies. It requires significant expert knowledge, time, and capital – and in the end, companies end up plagued by long IT project cycles and low return on investment. Thus, ready-built, open, reference platforms [4] and components such as ZDMP can simplify the development of zApps by easily connecting existing (and new) devices, sensors, and the multitude of data generating and actuating applications [5]. The enabled connections to information systems and operational assets is aimed to deliver more comprehensive business value than a do-it-yourself platform built from scratch.

Another critical element is the support of existing technologies and standards and to not re-invent the wheel. As Bob Harden, Principal, The Harden Group stated: "*…purchasing 10-20 different services from 10-20 different vendors using 10-20 different Apps with 10-20 different user interfaces. If that's the way IoT goes, it will be a long tough slog to Nirvana*". Thus, what is needed is a holistic, yet modular, platform [6] which is growable and featureful to service the wide range of users, user types, user domains, and user sizes to which it could fulfil a need.

4. Business Opportunities

Zero-defects Digital Manufacturing Platform (ZDMP), will be designed and developed according to the following principles: Ubiquity, Elasticity, Extensibility, Interoperability, and Openness: **"Ubiquity"** refers to the "ubiquitous factory" based on the plant-wide integration and optimization across the whole enterprise workflow. Therefore, a ubiquitous factory can be defined as a factory system in which autonomous and sustainable production takes place by gathering, exchanging, and using information transparently anywhere, anytime. It will include networked interaction between humans, machines, materials, partners, customers, suppliers, and systems, based on ubiquitous (available) ICT technology and manufacturing technology. **"Elasticity"** refers to the ability to cope with the increase/reduction of both the ICT (Computation, Data, Services, APIs…) and manufacturing

(Factories, Plant, Lines, Stations, Goods…) resources of the ZDMP Platform which are necessary for zero- defect production, based on the needs of individual production processes. The challenge is to fully exploit new concepts and technologies that allow manufacturing companies (especially mid-caps and SMEs) to fulfil the demands from changing supply and value networks without compromising quality. **"Extensibility"** of the ZDMP Platform is necessary to apply the delivered solution to different domains or problems that may arise in the future. This is ensured by the compliance with technology standards, information models, processes models, and an open, interconnected, and receptive approach that enables developers to build custom applications on top of this platform [7] [8]. Extensibility through applications is key in ZDMP – its (new) Apps can be requested by individuals or groups of users, developed by software/hardware companies, and then placed, if applicable, on the ZDMP marketplace. **"Interoperability"** allows the ZDMP Platform, which contains modules offering different technologies such as: Data analytics, pattern recognition, or artificial vision to be interconnectable to multiple real-world systems and applications easily and cheaply through the provision of configurable gateways, connectors, and data- interoperability features. Interoperability is critical in Industry 4.0. **"Openness"** infers the ZDMP infrastructure is based on an open architecture platform [9], open I/O protocols [3], open operating system, open source where appropriate, open feedback processes, and an open engagement with its ecosystem. Such scenarios are typical in today's open world and it enables a plug-and-play modular environment which reduces the cost of application development, platform use, and integration.

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6. References

[1] D. Preuveneers, E. Ilie-Zudor "The intelligent industry of the future: A survey on emerging trends, research challenges and opportunities in Industry 4.0" Journal of Ambient Intelligence and Smart Environments, 9(3), 287-298.

[2] C. Coutinho, L. Lopes, V. Viana, D. Pape, G. Klasen, B. Von Halem, O. Garcia Perales, L. Stellingwerff, A. Stam "An open environment for development of manufacturing applications on vf-OS", Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability, 2018, p. 107-114.

[3] V. Anaya, N. Moalla, L. Stellingwerff, J.L. Flores, F. Fraile "vf-OS IO Toolkit", Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability, 2018, p. 91-97.

[4] F. Fraile, R. Sanchis, R. Poler, A. Ortiz "Reference Models for Digital Manufacturing Platforms" Applied Sciences, 9(20), 4433.

[5] A.A. Nazarenko, J. Giao, J. Sarraipa, O.J. Saiz, O. Garcia Perales, R. Jardim-Gonçalves "Data Management Component for Virtual Factories Systems", Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability, 2018, p. 99-106.

[6] L. Manteigas Da Cunha, L. Stellingwerff, A. Stam "A Novel Approach to Software Development in the Microservice Environment of vf-OS", Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability, 2018, p. 115-119.

[7] P. Corista, J. Giao, J. Sarraipa, O. Garcia Perales, R. Almeida, N. Moalla "Enablers Framework: Developing Applications Using FIWARE", Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability, 2018, p. 83-89.

[8] R. Sanchis, O. García-Perales, F. Fraile, R. Poler "Low-Code as Enabler of Digital Transformation in Manufacturing Industry" Applied Sciences, 10(1), 12.

[9] D. Pape, T. Hinz, O. Garcia Perales, F. Fraile, J.L. Flores, O.J. Rubio "vf-OS Architecture", Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability, 2018, p. 77-82.