ZDMP Blog

Manufacturing industry in the 4.0 world

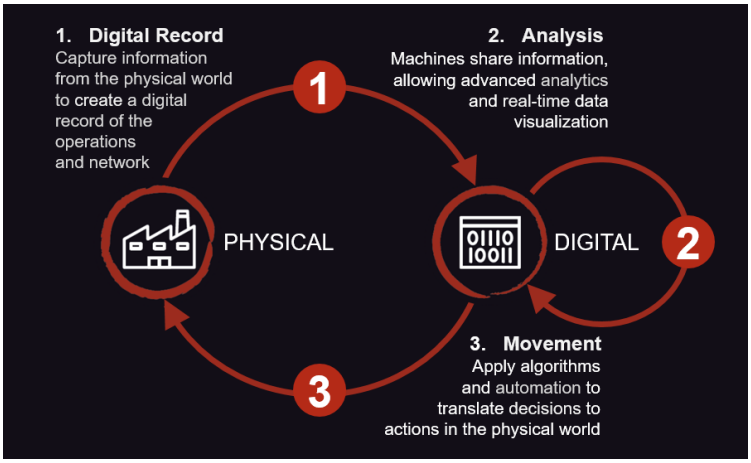
By Paolo Alocco, Alessia Focareta, Andrea Caporossi, FIDIA S.P.A.

Some questions for you

- Do you think transition to Industry 4.0 has no advantages for your industrial sector?
- Can you use your equipment as simply as the apps on your phone?
- Can you trace back all components you use to their manufacturers in one click?

Zero Defects and the fourth industrial revolution

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. To remain competitive and keep its leading manufacturing position, European industry must produce high quality products at a low cost, in the most efficient way. The Fourth Industrial Revolution, commonly known as Industry 4.0, appears to be changing the way businesses function and, by extension, their way of competing. Organizations must decide how and where to invest in these new technologies and identify which ones might best meet their needs.



Real-time access to data and intelligence is driven by the continuous and cyclical flow of information and actions between the physical and digital world.

This flow occurs through an iterative series of steps in a physical-to-digital-to-physical loop:

- **Physical to digital**: Capture information from the physical world and create a digital record from physical data
- **Digital to digital**: Share information and uncover meaningful insights using advanced analytics, scenario analysis, and artificial intelligence
- **Digital to physical**: Apply algorithms to translate digital-world decisions to effective data, to spur action and change in the physical world.

To achieve this process, Industry 4.0 combines relevant physical and digital technologies, including analytics, robotics, high-performance computing, artificial intelligence, and cognitive technologies. The digitization of operations, manufacturing, supply networks and products enables companies to combine information from humans, machines, analytics, and predictive insights to make better, more holistic decisions [1].

Modern manufacturing is driven by rapid technological changes. High-value manufacturing processes are increasingly moving towards flexible and intelligent production systems. With the rise of product customisation, industries have shifted to manufacturing methods based on lean practices and customer demands. Setting aside the increased necessity for adaptability in both production and management processes, it also becomes much more challenging to apply systematic methodologies for monitoring and preventing the occurrence of defects in production [2].

In the context of Industry 4.0, a Zero Defects Manufacturing (ZDM) Strategy has a goal to decrease and mitigate failures within manufacturing processes and “to do things right first time.” In other words, it aims to prevent or, when impossible, to detect and discard defective parts during production. Zero Defect Manufacturing can be product oriented or process/machinery oriented. Product oriented ZDM analyses the defects on actual manufactured parts and tries to find a solution whereas the process/machine oriented ZDM studies the defects of the manufacturing equipment or process and infers the quality of the produced parts.

ZDM consists of four strategies: Detect, repair, predict, and prevent. When a defect is detected recovery actions can be undertaken and the data gathered can populate specifically designed algorithms for defect prediction and therefore prevention [3].

While the advantages of the Zero Defect Manufacturing Strategy are well known in every manufacturing sector, its implementation is not necessarily widespread in the operational environment. For example, the ZDM concept requires a huge amount of data. The generation of such data is limited by the scarce digitalization of the production lines, the need for standardized formats and the collection and manipulation of data is impeded by the missing digital expertise and computational power of manufacturing companies.

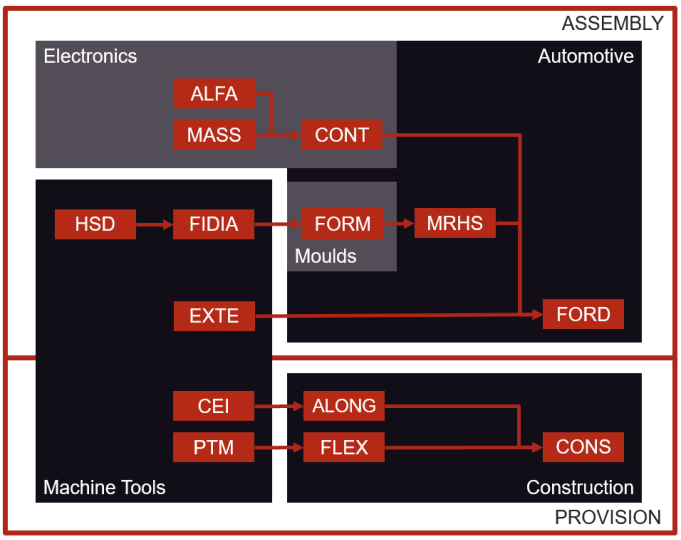
The Zero Defects Manufacturing Platform answers the needs for digital skills and computational power that are missing for a wide application of all zero-defect oriented technologies.

Technical Advancement ZDMP

The main objective of ZDMP is to develop a Zero-Defect Manufacturing Reference Platform, Apps, SDK, and Marketplace for Product and Process Quality in any factory. Despite sectors such as automotive and construction being very different, they have some things in common, for example, the necessity to track products, the will for an easier communication across their value chain and the aim to detect quality issues at the earliest possible stages of production. ZDMP will allow end-users to connect their systems to benefit from the features of the platform. These benefits include products and production quality assurance.

Technical advancements in ZDMP will provide to the manufacturing domain:

- **Quality inspection technologies**: Pre-production, in-line and final inspection tools will be made available in the platform. These tools will gather data with non-destructive methods at various stages of the manufacturing processes
- **Quality inspection analytics**: Analysis of the data gathered by the inspection tools, enabling the predictive maintenance for systems and processes
- **Self-learning systems**: Self-Learning systems using algorithms that can learn from the past events to improve their performance
- **Industrial IoT**: The ZDMP platform provides a high degree of interconnection between the elements that form part of the industrial system and the surrounding environment (customers, suppliers, markets, etc), as well as the implementation of machine-to-machine communication
- **Supply Chain Shared Access**: The ZDMP platform offers different actors of the supply chain to have access to the shared resources, as well as to have easier, faster and more secure communication
- **Large Scale Data Collection**: Data can be gathered from many sources and from many different companies.
- **Scheduling and tracking:** The ZDMP platform allows tracing materials and products during different processes and at different stages of the supply chain



ZDMP technologies are going to be tested to face several types of challenges in four manufacturing domains:

- Automotive
- Machine tools
- Electronics
- Construction

Automotive

The automotive sector in ZDMP is represented by the supply chain of the cylinder block production. The supply chain is composed by an equipment manufacturer (ETXE), a supplier of rough parts (MRHS), and the manufacturer (FORD).

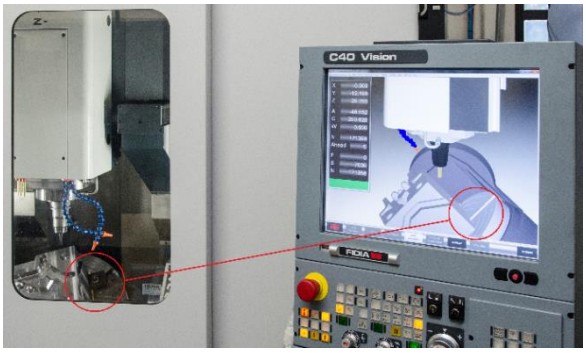
The main challenges identified within this sector towards the zero-defects manufacturing concept are:

- **Management of large datasets**: The focus is on a fully automatic production and the data gathered on a single production batch come from several different pieces of equipment on this line. ZDMP enables companies to achieve this result, without having to hire a Big Data analysts

- **New physical variables**: In a production line, checking the quality of a component halfway along it and detecting a failed part early on in the production process can be extremely valuable, as it eliminates further unnecessary manufacturing steps on those non-conformant parts. To gather quality data early on, the production lines need to be equipped with additional sensors and cameras. ZDMP offers the flexibility to add data streams and manage them correctly
- **Automatic analysis**: The large datasets require automatic tools for data analysis. ZDMP provides several AI algorithms for this purpose

Machine tool

The machine tools sector in ZDMP is represented by the supply chain of mould production. The supply chain is composed by an equipment manufacturer (FIDIA), a supplier of machine complex components (HSD), and the mould manufacturer (FORM).



The main challenges identified within this sector towards the zero-defects manufacturing concept are:

- **Compatibility with external tools**: External tools usually require interfacing effort and compatibility that cannot be afforded for the small quantities produced. The ZDMP platform offers online services that can overcome the compatibility problems
- **Communication with external services**: Small and medium sized companies often rely on external maintenance services for their equipment. Having to call the service rarely, their communication system is rudimental, resulting in the need to visit the customer to inspect the equipment personally, even for the problems that could be solved remotely. ZDMP offers the possibility to share databases with external companies and to support remote work
- **Lot size one:** Quality analysis for small lot sizes is difficult, because often there is a lack of data. ZDMP algorithms offer flexible analysis capabilities to face this challenge

Electronics

The electronics sector in ZDMP is represented by the production of electronics displays. The supply chain is composed by an X-Ray equipment manufacturer (ALFA), an assembly lines service provider (MASS), and the manufacturer (CONT).

The main challenges identified within this sector towards the zero-defects manufacturing are:

- **Management of visual data**: Data coming from cameras and X-Ray analysis are quite large and difficult to manage. ZDMP enables companies to better exploit these data providing a platform to manage the data flow and storage
- **Quick reconfiguration of the assembly line**: ZDMP provides a solid connection to the entire line and a single access point to simplify the management of the line as a whole
- **Centralized control on quality**: As the final quality is the result of all the quality checks during all manufacturing steps that, for an assembly line it is a large number, there is a necessity to manage all quality information at the organisational level, as well as at equipment level. ZDMP offers the flexibility to merge real-time quality data from all stations of a production line and manage them correctly

Construction

The construction sector in ZDMP is represented by the supply chain of stone tiles and steel tubes production and provision to construction companies. The supply chain is composed of two equipment producers (CEI, PTM), two construction materials manufacturers (ALONG, FLEX), and the construction manager (CONS).



The main challenges identified within this sector towards the zero-defects manufacturing are:

- **Capability to share data along the supply chain**: Having quality data from the supplier and sending back data supported feedback benefits both parties. ZDMP provides a common platform to connect and share this information safely
- **Introduction of new technologies**: The construction sector is traditionally scarcely digitized and usually lacks an IT infrastructure. For this reason, the industry 4.0 approach is more difficult to implement. ZDMP offers a platform accessible from many different devices and applications that can work in the cloud.

ZDMP Links

• **Architecture Component(s)**	N/A
• **Work Package**	WP9, WP10 – Use cases
• **Tasks**	All tasks

References/Acknowledgements

[1] Mussomeli et al., The rise of the digital supply network.
[2] Wang, KS. Adv. Manuf. (2013) 1: 62. https://doi.org/10.1007/s40436-013-0010-9
[3] Taisch M, Arena D, Gorobtcova P et al. (2018) World Manufacturing Forum Report, Recommendations for the Future Manufacturing