CogniZDM

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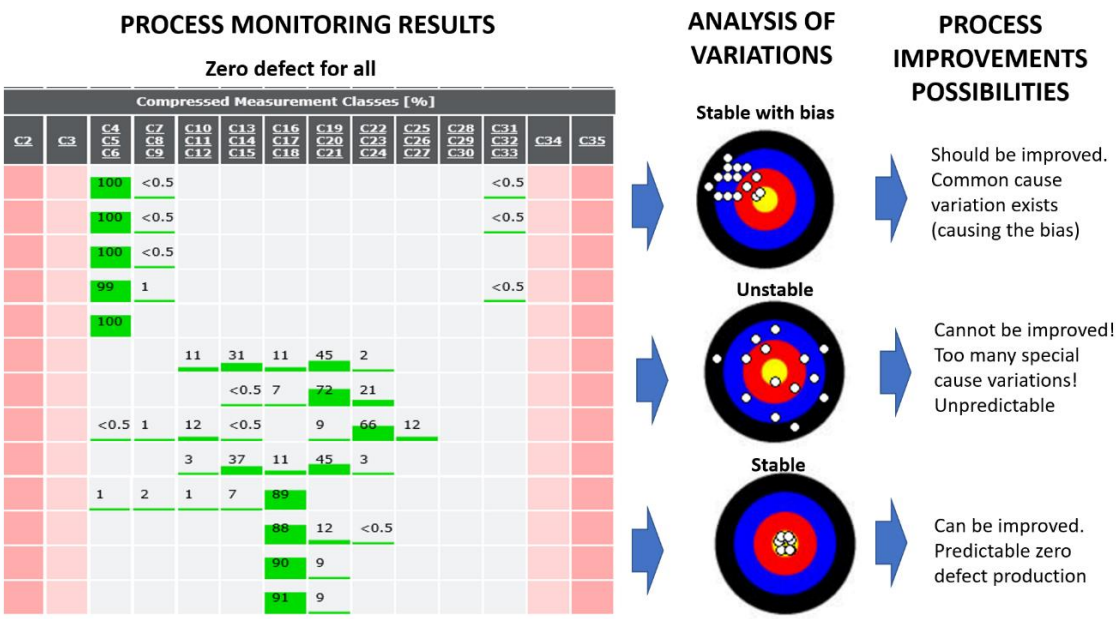
Cognition-driven ZDM for early detection and understanding of unusual process behaviour

By Nenad Stojanovic, Nissatech

Project Details and Motivation

One of the most critical factors in zero defect manufacturing (ZDM) are the instabilities/unusuality in the processes, which make processes unpredictable (difficult to control) and lower the product quality (more anomalous products). They are caused by the variations (fluctuations) in the process parameters. In the case of huge, multidimensional and heterogenous process data (as usually found in the manufacturing domain), simple, univariate, or low-dimensional approaches for detecting variations (like control charts from Statistical Process Control, as a part of Six Sigma Methodology) are not enough for spotting process instabilities and unusuality accurately and timely.

Based on Nissatech' s past and ongoing work in multivariate data analytics for zero defect manufacturing and current work on cognition-driven systems for improving process quality, a novel approach is proposed for ZDM driven by a proactive detection of complex variations in processes, their understanding (root-causes) and impact analysis, with the goal to spot unusual behaviour of a process and validate it (since not every variation leads to problems) before it starts producing defective products. It is based on the cognition process, which reflects the way how human process uncertain/unusual situations (perception, interpretation, and decision). The main advantage is that the approach is focused on monitoring and understanding process behaviour (as a whole) and not "isolated" anomalies. In other words, it explains the process behaviour on a higher (health) level, contextualising other data-driven analyses, such as anomaly detection which detects anomalies but misses their understanding in a broader process context. Consequently, it enables the substantial improvement of the methods for ZDM, like the precision of generated alarms (less false positives) in anomaly detection and confidence in the discovery of early warnings in predictive maintenance.



Motivating example

Focusing on “only” zero defects has a drawback that the variations in the process are not considered properly as illustrated in the figure above. Briefly, each row in the table above represents the summary of the statistical distribution of the value of a process parameter and none of parameters shows outliers (all in green) - this leads to zero defects and the process owner can be satisfied with performances (and KPIs). However, three groups can be identified, as presented using the Shooting targets in the middle of the figure: stable with bias, unstable and stable and their visual interpretation is clear. In addition, as explained in the third part of the figure, only the stable “shooting” is zero defect in long run. However, most of companies considers “green or red” classification, neglecting the so called “red-green zones” (unstable/red, but capable/green process instances) which is the most important part for the process improvement activities. According to recent analyses, this kind of processing can bring up to 50% of improvement, if applied on the entire process. The goal of the project is to exploit that potential.

The outcome is an innovative ZDMP-enabled solution, cognition-driven ZDM (CogniZDM), based on existing ZDM components and integrated in the ZDMP Platform

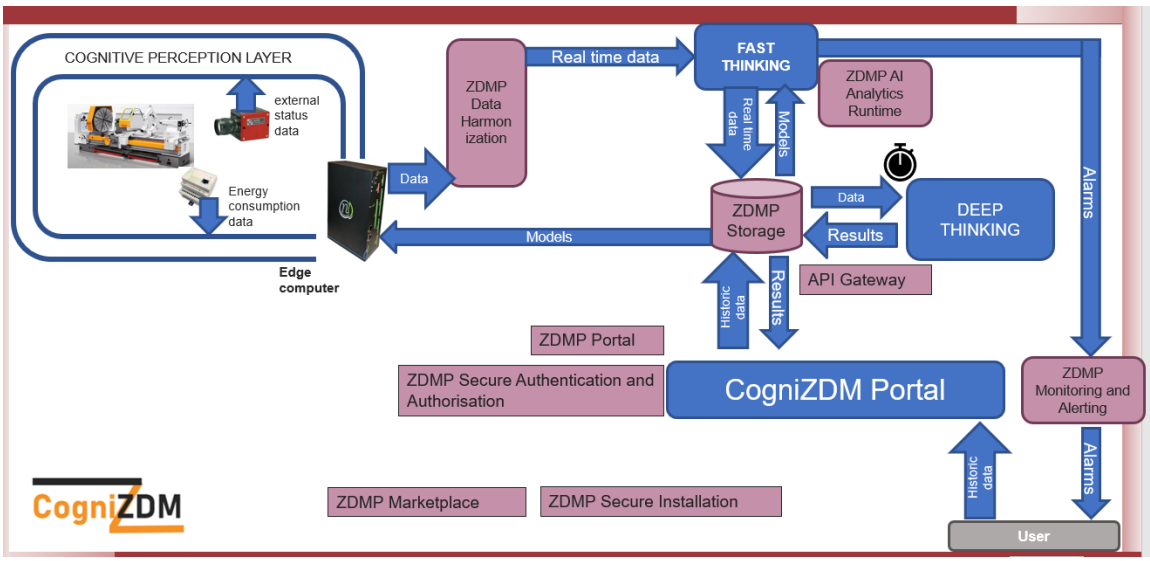
ZDMP Fit

The proposal contributes to ZDMP project to provide an extendable platform to support factories to help them reach a goal of zero defects with a focus on product and production quality assurance, contributing explicitly to ZDMP objectives: “To provide an Industry 4.0 (I4.0) Platform for developing zero-defect solutions” and “To ensure outstanding process quality, through equipment, resource, and energy efficiency, by deploying novel AI based solutions”, by offering new AI-driven services for cognition-based ZDM.

The following components will be used:

- ZDMP **Data Harmonisation** for harmonising the data from a variety of sources into the required formats
- ZDMP **Storage** for storing the data collected from the edge as well as the data-driven models derived from the learning process
- ZDMP **AI Analytics Runtime** for supporting the Real-time smart services, by enabling an efficient deployment of learned AI (data-driven) models
- ZDMP **Monitoring and Alerting** for allowing data collection from machines and alerting in case a KPI gets out of defined limits
- ZDMP **Portal** for enabling user interaction with available assets/services/data
- ZDMP **Secure Authentication and Authorisation** for enabling authentication and authorisation for ZDMP assets

The following figure illustrates the architecture.



CogniZDM high-level architecture. Blue: CogniZDM custom functionality, Pink: ZDMP zComponents

Participant Details

- **Organisation(s) involved: Nissatech:**
  - **Web:** https://www .nissatech.com/research-development/
  - **Contact**: Nenad.Stojanovic@nissatech.com
  - **Profile:** Nissatech is a twelve-year old, innovation-driven SME with strong international cooperation and vision to become one of the top European innovators in the domain of advanced AI and cognitive industrial solutions. The main objective is to develop its own technological building blocks through an efficient implementation of the cutting-edge research and their usage for resolving very challenging real-world problems in different industrial domains. The company has very good connections with several leading research organisations in Europe, based on the past affiliations of the part of the management. The major competitive advantage is based on a very high innovation potential and strong engineering skills that enable an efficient early adoption of technologies that can improve our core competencies. Our social responsibility is driven by awareness of the need for green and social innovation in any technological progress.
    Current work is driven by several innovations related to mCognitive Digital Twins, new paradigm for describing the behaviour (design- and real-time) of complex real-world assets (process, systems) using AI methods and cognitive architecture, focusing on hybrid modelling of the asset behaviour. It enables the process of cognitive retrofitting, a step towards Industry 4.0

ZDMP Details

The ZDMP – Zero Defects Manufacturing Platform – is a project funded by the H2020 Framework Programme of the European Commission under Grant Agreement 825631 and conducted from January 2019 until December 2022. It engages 31 partners (Users, Technology Providers, Consultants and Research Institutes) with a mission to “Provide the platform, components, services, and marketplace to achieve the right product, at the right time, with the right conditions using the right resources.". Further information can be found at www.zdmp.eu. ZDMP channels 3.2M€ of SME orientated funding to subprojects, such as this one to both facilitate SMEs with their innovations and increase the value of the ZDMP ecosystem

Links

• **Sub project website/blog**	https://www.nissatech.com/research-development/
• **Architecture Component(s)**	https://www.zdmp.eu/documentation
• **ZDMP Website**	www.zdmp.eu