Zero-defect manufacturing strategies towards on-line production management for European factories.

The Problem

European manufacturing sector is leading the world in areas such as automotive, machinery and agricultural engineering. However, it is threatened by both the lower-wage economies and other high-tech rivals, and the situation of EU companies was even made more difficult by the downturn. Nowadays, the efficiency and sustainability of the manufacturing processes of high-tech products depend on the introduction of Advance Manufacturing Technologies in the production processes. In particular, the development of metrology solutions for zero defect applications is considered as a robust technology able to provide a vast competitive advantage to manufacturing companies.

Z-Fact0r Overall Objective

Z-Fact0r aspires to enable manufacturing enterprises to achieve high precision manufacturing of complex products, and to initiate a fundamental rethinking process on how to increase the accuracy of machines and improve control. The improvement should not only concern the individual machines as isolated islands but encompass the totality of production process as a system of interrelated elements that seek to maximise efficiency, productivity, customer satisfaction; whilst at the same time eliminate waste and excess inventory.

The objectives are classified in three groups:

**Industrial**

- Develop a sustainable manufacturing system, high performance, reducing environmental impact and waste.
- Develop strategies for zero defect manufacturing, ensuring human safety.
- Develop a system integrating green scheduling, reducing consumption and waste generation.

**Technical**

- Detect defects, predict production, reduce defects, products specifications and cost awareness.
- Develop a system with the ability to detect events and produce intelligent & cost-effective reports.
- Develop strategies for manufacturing and quality control.
- Develop strategies for reducing operation time of single and multi-stage production.
- Develop strategies for reducing the number of breakdowns.
- Develop strategies for cost-effective defect detection.
- Develop strategies for production interruption.
- Standardisation

**Sustainability**

- Reduce the environmental impact of production processes.
- Reduce the consumption of raw materials.
- Reduce the waste generated from production processes.
- Reduce the carbon footprint of production processes.

**Environmental**

- Reduce the consumption of raw materials.
- Reduce the waste generated from production processes.
- Reduce the carbon footprint of production processes.

**Social**

- Reduce the number of breakdowns.
- Reduce the number of defects.
- Reduce the number of accidents.
- Reduce the number of complaints.
- Improve the quality of products.
- Improve the safety of workers.
- Improve the satisfaction of customers.

**Econom**

- Reduce the cost of production.
- Reduce the cost of materials.
- Reduce the cost of energy.
- Reduce the cost of waste.
- Reduce the cost of breakdowns.
- Reduce the cost of defects.
- Reduce the cost of accidents.
- Reduce the cost of complaints.
- Improve the quality of products.
- Improve the safety of workers.
- Improve the satisfaction of customers.

**Outcomes**

Z-Fact0r novel correlation of machine behaviour with the process performance and the produced quality will provide a vital feedback to the control loop in manufacturing systems. Key benefit of the Z-Fact0r employment will also be the reduction of the maintenance and inspection costs as well as the repair costs due to the reduced number of breakdowns due to the optimised performance. Economic and environmental benefits are expected on a European scale. Z-Fact0r will also noticeably increase the demand for highly skilled personnel, influencing society in a decisive way.

**Strategies**

The Z-Fact0r solution comprises the introduction of five (5) multi-stage production-based strategies targeting (i) the early detection of the defect (Z-DETECT), (ii) the prediction of the defect generation (Z-PREDICT), (iii) the prevention of defect generation by recalibrating the production line (multi-stage), as well as defect propagation in later stages of the production (Z-PREVENT), (iv) the reworking - remanufacturing of the product, if this is possible, using additive and subtractive manufacturing techniques (Z-REPAIR) and (v) the management of the aforementioned strategies through event modelling, KPI (key performance indicators) monitoring and real-time decision support (Z-MANAGE).

**Microsemi use case**

Microsemi Semiconductor Ltd, a division of the Microsemi Corporation, manufactures miniature electronic modules for medical, security and communication industries. During this use case, the manufacturing process of PCBs will be monitored and controlled. The assembly is a multistage process starting with Visual inspection of the base PCB, Glue dot dispense, Placement of the die/component, Glue cure, and Wirebond die. Z-Repair will be also implemented off-line.

**Synergies and interactions between the five Z-Fact0r strategies**

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