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MONITORING ANTI-ERROR SYSTEMS AIMED AT MANUFACTURING PROCESSES-FLEXIBLE CELL MODULE-MONITORING MODULE

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ABSTRACT: The paper presents the experimental model for flexible cell module-monitoring module, product to be used at industrial platform in Mioveni. This module is an anti-error monitoring system. The large expertise acquired during the projects run in collaboration with "S.C. Automobile Dacia", as well as with other economic agents in motor vehicles industry, projects during which the experts from INCDMTM Bucharest and INMA have faced different situations where designing and installing anti-error systems allowed to significantly reduce costs and increase quality.
KEYWORDS: acoustic, poka - yoke, quality, flexible cell module, monitoring module

❖ INTRODUCTION

The current and future industrial context is characterized by an accelerated dynamics of manufacturing processes as the quality management requirements have become a priority concern.

The Quality System,, Zero Faults" (ZDQ) is a concept from quality field, which requires ZERO faults manufacturing and removing the losses related to troubles. This concept is based on a system where the flaws are prevented and the process control should assure that products are appropriate, without any flaw.

„Zero faults" concept can be achieved by *eliminating the losses caused by*: cultural factors, intrinsic variation of processes, the complexity of processes or products and the human errors. These losses are determined by: overproduction, delays (waiting time), transport, process additional activities, stocks, movements, defected products, blocked resources, resources unappropriately used.

The intrinsic variation of the processes results from:

1. Procedures or standards unappropriate;
2. Machines and equipment
3. Unsuitable material
4. Control Tools and Devices worn-up
5. *Human errors*

For principal or causal reasons, the errors in manufacturing process related only to persons (human errors) involved in technical process are : overlooking, misunderstanding, unappropriately identifying, lack of expertise, ignoring rules or procedures, neglecting, lack of order and rigour, slowing down, (loosing time), lack of standardization, unexpected machine operation, intended error (sabotage).

In order to eliminate the recurrent errors is necessary to use anti-error techniques.

The vehicle industry has been the key element which determined the development of concept of continuous improvement of quality (Lean manufacturing) and where the anti-error systems have a large applicability.

Poka Yoke is a concept of quality management developed by a production engineer named Shigeo Shingo. The main objective of poka-yoke is obtaining zero faults products. The Japanese philosophical principles "kaizen" and "poka-yoke", have been applied to suppliers of Mioveni plant, thus, synthesizing the Oriental working philosophy, that "conceives the whole production area as a system, where each process directly influences the other".

❖ MATERIALS AND METHODS

The vehicle building plant "Automobile-Dacia" largely uses the techniques of continuous improving the quality of manufacturing process.

The anti-error systems (Poka-Yoke) are frequently met within the manufacturing lines and importantly contribute to reducing costs and raising the quality.

On the industrial platform at Mioveni, poka-yoke extends also to suppliers of Dacia factory, so that the production failures be forbidden either from the suppliers to manufacturer or vice versa.

Moreover, Dacia has created a unique database comprising all poka-yoke files related to vehicles, processes and component parts of the plant, organized according to problems identified at a certain moment.

The experimental model for the module of flexible cell-monitoring module frames within unique operations category, company equipment, which are not offered on the market, being designed to assuring the production quality in motor vehicles industry.

The domain in which the experimental model is intended to be used is the industrial field, a very demanding field requiring material and human resources of high quality, respectively high accuracy equipment and apparata, good raw materials and, the most important, well skilled personnel, whose expertise is the result of many years of practice. The wireless transmission systems, included in monitoring and warning systems of flexible manufacturing (with a high level of diversity) represent a distinct chapter of industrial electronics, the component marks of these products type having to be analysed very strictly in terms of rules in force and reliability.

Measuring the operating parameters of anti-error systems is performed with complex benches, usually achieved by self-equipping by companies manufacturing such products, when they have the means to solve the problems or collaborate with specialized institutions in the field such as, the research and design institutes, the high education institutes, specialized commercial companies.

The qualitative level of most recent benches generation is very good, they being endowed with microcontrollers, computers PC and software appropriate to measuring the electromagnetic disturbances and interferences, data acquisition, data processing and taking the decision, the recording and listing the information related to process running being able to achieved according to each case.

The unit scheme of the module is shown in figure 1 and comprises the following operating units:

- Reading module RFID;
- Power unit 1;
- Power unit 2;
  Monitoring module;
- Serial communication module;
- WIRELESS PANIC module;
- WIRELESS BLUETOOTH module;
- Module of connectors;
- UC module

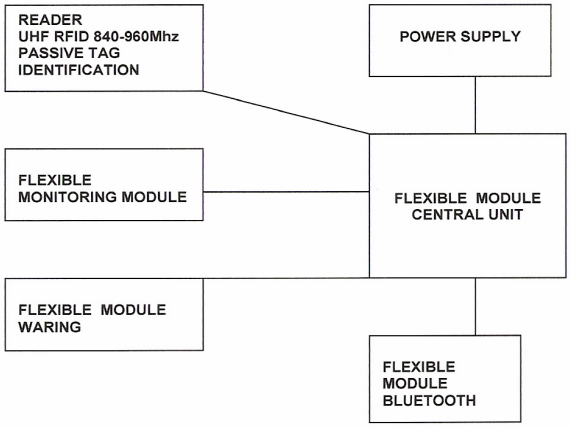

Fig. 1. Unit scheme of module

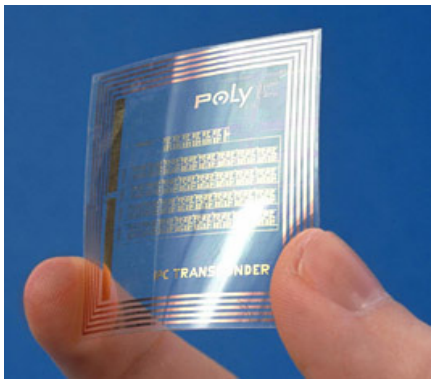

Fig. 2. RFID tag pasiv

Reading Module RFID is made of the coil L2 with 370 μH inductance within a plastic frame of 80/40 mm dimensions and wired to circuit according to annexed schemes.

The circuit determines at 200 mm distance the presence of a RFID-tag passive, figure 2.

POWER UNIT 1 is a DC/DC highly efficient converter built with a circuit MC34713 in configuration BUCK and assures an outlet voltage of 3.3 V /1A necessary to supply the wireless communicating circuits.

POWER UNIT 2 is a DC/DC highly efficient converter built with a circuit LTC3770 in configuration BUCK and assures an outlet voltage of 5 V /2A necessary to supply the central unit with a microcontroller.

MONITORING MODULE follows the signals received from the module RFID, WIRELESS PANIC and BARIERE IR and optically warns on a panel comprising a network of 80 leds SMD disposed in a matrix, acoustically prevents and transmits the message to the central unit.

SERIAL COMMUNICATING MODULE – is a standard level converter of RS232 type MAX3221 with socket DB9.

WIRELESS PANIC module is a miniature transmitter endowed with panic button and led of signalling the battery state. The emission rate is 433.92 Mhz according to standards.

MODULE WIRELESS BLUETOOTH – uses a miniature Bluetooth PARANI module and processor MSP430 and a receiver IR of TSOP34840 type.

MODULE OF CONNECTORS – assures the connection between UC and RFID reader and UC and monitoring modulule.

CENTRAL UNIT MODULE - UC built around a microcontroller MC9S12UF32 connecting to Bluetooth module and serial communication RS232 but has also a port USB for firmware update and boot loader.

❖ RESULTS AND DISCUSSIONS

Within INCDMTM Bucharest, numerous equipment and anti-error systems have been designed, achieved and operated, at the demand of "Automobile Dacia Pitești".

Therefore, on the engine assembling line, have been placed approx. 10 points where the operators should mount certain sub-assemblies, depending on the type of engine in respective points, automated systems allowing to:

- Identify the engine type by reading the bar code;
- Optical signalling systems of compartments in a "piece of furniture" especially manufactured for this purpose, where the sub-assemblies suitable to identified the engine type can be found;
- Signalling the correct (incorrect) action of operator by using some devices which detect the operator's hand presence in unappropriate compartments;
- Similar systems designed to logistics sector have been provided in order to prevent the unsuitable supply of „furniture" with subassemblies;
- Within the mounting section, similar installations have been placed in order to assist the operators in different points;
- Mounting radiators and compensating devices;
- Assembling/equipping the wheels for choosing the type and values of weights used at dynamic balance;
- Board panel mounting
- Selecting the relevant documents according to the final geographical destination of the vehicle.

A particularity of the systems belonging to general mounting section consists in the complete identification of vehicle in each point by using an informatics system watching the manufacturing and allowing a serial dialogue with each point.

The anti-error installation also placed at the station of pistons mounting allows the operator to make the correct choice depending on the automatic measurement of specific dimensions. On cylinder cover mounting line was installed an equipment which determines automatically the cam followers backlash, assisting the operator to choose and mount them appropriately.

An other anti-error system type monitors the operator for developing the suitable actions specific to respective point, in their appropriate order and without flaws. Such a system has been installed at AutoChassis International, which is an important supplier of component parts for Automobile Dacia in order to verify the wing spare screws.

At the same time, there is a system frequently used allowing to detect the presence and position of holes on different subassemblies and where they are thread or not.

The large expertise acquired during the projects run in collaboration with "S.C. Automobile Dacia", as well as with other economic agents in motor vehicles industry, projects during which the experts from INCDMTM Bucharest and INMA have faced different situations where designing and installing anti-error systems allowed to significantly reduce costs and increase quality.

The analysis performed after this test has identified some characteristic component modules existing in all the situations:

- module "**identification**" designed to characterize the concrete situation of assisted point;
- module "**signalling**" designed to indicate to operator the appropriate actions;
- module "**monitoring**" designed to monitor the operator concrete action;
- module "**control and decision**" designed to correlate the information coming from the other modules, make the decision related to respective process (warning, stopping, etc) and communicate to the hierarchical upper levels.

Topology scheme of anti-error monitoring system is shown in figure 3.

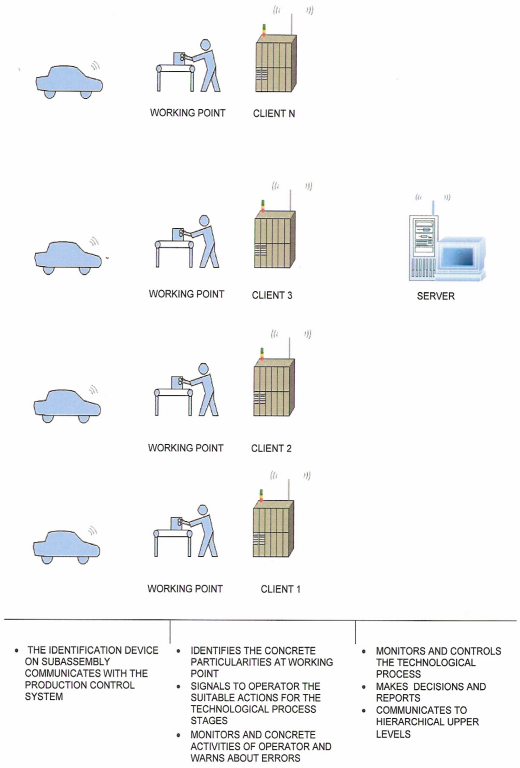

Fig. 3. Topology scheme of the system

- **Electric characteristics of modules:**
  - Power supply — 24V DC
  - Emission rate of panic button — 433.93 Mhz
  - Bluetooth emission rate — 2.43 Ghz
  - Monitoring radius — 30m
  - Scanning speed: — 30 (60) m/sec
  - Time of response to detection IR — 1.32 usec.

❖ CONCLUSIONS

Following the tests of monitoring module, it has been found that it meets the beneficiary demands by:

- Adapting flexibility - each module is endowed with a SD-card on which can be written standardized files of production and quality control depending on the parameters to be checked;
- wireless communication between the modules and UC and a central server for global control.
- reader RFID PASSIVE included (for exemple in the sleeves of the operator overall) and which fulfils both the function of anti-error monitoring (detects the part taken from a shelf and its options for the vehicle type in the current station) and safety (in case of hand entering a dangerous area).
- Self processing included, on basis of learning a maximum number of 8000 RFID- tag's by respecting the anti-colision (the specialized integrated circuit VMX2346 was used).
- button for wireless panic when one has to alert for emergency situations both technological situations and situations regarding the operator safety. It is a miniature portable transmitter endowed with button easily to be acted and which has similar function as the „mushsoom"-type button compulsory provided on every panel in order to be acted in case of emergency. The advantage of the solution presented is that the button is not placed on a fix cabinet but is joint to the operator and available anytime.

❖ ACKNOWLEDGMENT

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