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ELEMENTS OF STEERING AND QUALITY MANAGEMENT IN INTEGRATED COMPUTER SYSTEM OF METALLURGICAL ENTERPRISE

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The advanced information technology is presently used on almost all levels of the management of an enterprise. Most often, it functions in the form of modern information systems, a main component of which is a master enterprise management system and its assistant specialized information system targeted to servicing information & decision-making processes controlling the enterprise's business activity. The article presents the assessment of a computer management-aiding system and a quality assurance system in one of Poland's largest metallurgical enterprises.

Key words: *quality management, computer system, metallurgy, production management*

Elementi upravljanja poduzećem i kakvoćom u integriranom kompjuterskom sustavu metalurškog poduzeća. Napredna informatička tehnologija rabi se trenutno na gotovo svim razinama upravljanja poduzećem. Ona funkcionira u obliku modernog informacijskog sustava čija je glavna komponenta sustav upravljanja poduzećem, a njegov pomoćni specijalizirani sustav ima za cilj osiguranje informacija i procesa donošenja odluka glede kontroliranja poslovanja poduzeća. Članak predstavlja procjenu kompjuterskog pomoćnog sustava upravljanja i sustava osiguranja kvalitete u jednom od najvećih poljskih metalurških poduzeća.

Ključne riječi: *upravljanje kakvoćom, kompjuterski sustav, metalurgija, upravljanje proizvodnjom*

THE STEELWORKS' QUALITY ASSURANCE SYSTEM

A quality assurance system is an effective method of achieving increase in productivity and economic effectiveness, as well as the confidence of customers, who expect the supplier to assure a stable quality level. Thus, the essence of the system is continuous improvement, as the process of changes never ends.

The quality assurance system is used for carrying out the quality strategy which is a method of acquiring the customers through the continuous improvement of organization so that the attainment of the agreed quality level, accepted price and competitive delivery time of the product be assured. It is also a tool enabling the determination of the causes of nonconformities, the occurrence of nonconformities and their elimination. The quality management system established, documented and implemented in the steelworks is continuously improved.

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The quality assurance system in the analyzed metallurgical enterprise operates based on documentation that includes a quality manual, procedures, instructions and records. The purpose of the procedure is to set the rules of creating, updating and storing quality assurance system documentation. The subject of the procedure are principles and the mode of proceeding when:

- creating quality assurance system documentation,
- introducing changes to, indexing, reproducing, distributing and withdrawing it from circulation,
- storing and making it available [1].

Through its scope of application, the procedure covers all departments and divisions, and individuals taking part in the creation of Quality Management System documentation, its distribution, storage, withdrawal and making it available.

The Quality Manual contains the specification of key Quality Management System objectives in the steelworks, along with the quality management system description applicable within the whole enterprise. In addition, it describes the responsibilities, powers and interrelations of the managerial staff in the enterprise. It is also a quality management

tool for the top management. The Quality Manual documents the relations of the quality management system applicable in the steelworks with the requirements of the standard.

The proper functioning of the quality assurance system in the enterprise is also dependent on establishing quality objectives for respective functions and levels within the organization, together with the goals needed to be achieved for compliance with product-related requirements, see Figure 1.

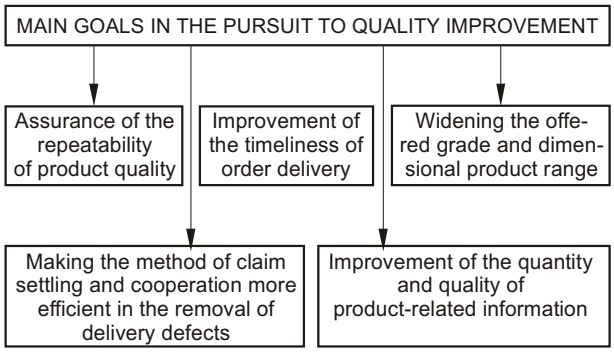

Figure 1. **Main goals set by the top management in the pursuit of quality improvement**
Slika 1. **Glavni ciljevi postavljeni od uprave poduzeća radi unapređenja kakvoće**

A process is to be understood as a set of interrelated or interacting activities, which transform the elements of the input vector into the elements of the output vector. The input to the steelworks' main process is customer expectations. The output of the process is the product. The assessment of quality objective performance is presented during Quality Assurance System inspections [2]. Periodical Quality Assurance System inspections in the steelworks are carried out twice a year: in January and in July, at the working meetings of the Steelworks Board of Management.

The inspection covers the essential elements of the Quality Assurance System, focusing on the discussion of any identified nonconformities and low effectiveness and the determination of corrective actions, and in particular it assures the assessment of:

- the effectiveness of previously determined corrective actions,
- the effectiveness of corrective actions undertaken based on internal and external audits,
- the progress of quality improvement plans implementation,
- the currentstate and effectiveness of procedures and instructions used, and
- the deployment of responsibilities, competencies and resources for carrying out the quality objectives set.

The assessment made as a result of the inspection is a basis for the formulation of recommendations, based on which corrective actions are determined [1].

The process quality plan covers all inspection and testing activities and related records, starting from the charge supplies through to the delivery of the product to the customer.

The technological process is run in the steelworks in a continuous manner, therefore the process quality plan covers repeatable activities and records. Any changes to the process quality plan occur most usually as a result of production modernization and investment activities and changes to the inspection & testing equipment. Due to the fact that all the steelworks' products are manufactured in continuous processes, they are covered by the same process quality plan [3].

Quality plans encompass process and inspection activities, as well as activities related to the preparation of the production process. Each activity is described by relevant documentation, which includes procedures and instructions.

GENERAL PRINCIPLES OF THE FUNCTIONING OF THE INTEGRATED COMPUTER SYSTEM IN THE STEELWORKS, AND ITS EXTENT AND FUNCTIONS

The EBX system is an integrated computer system functioning in the steelworks, which enables the two highest managements levels to control and supervise the enterprise. The range of EBX function extends to Production, Sales and Finances; however, it is only part of the whole solution. The are

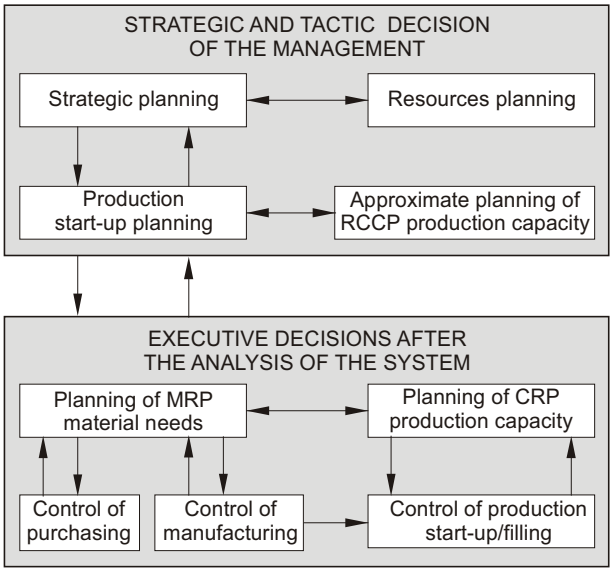

Figure 2. **Model of the MRP II system**
Slika 2. **Model sustava MRPII**

people who are equally important; often, they require further education and training associated with the implementation of such a system. Such services can only be provided by a team of experienced experts who are able to understand the problems and realities of the enterprise and its specificity.

The EBX integrated management system is a management-aiding system of MRP II and ERP classes. It covers spheres of the enterprise (Figure 2.).

Terminals are distributed in different organizational units, and are accessed by designers, process engineers, and the personnel of general planning, departmental planning, purchasing, stores, quality control, sales and marketing.

The software is composed of a dozen or so modules related to the following areas: marketing, finances, planning and production (Figure 3.).

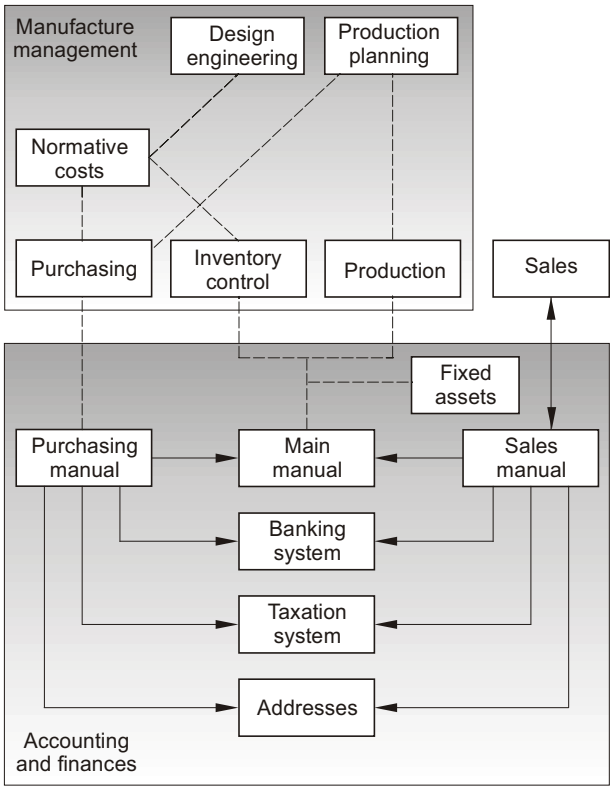

Figure 3. **Elements of the functioning EBX system**
Slika 3. **Elementi funkcioniranja sustava EBX**

ELEMENTS OF QUALITY CONTROL AND MANAGEMENT IN THE STEELWORKS' INTEGRATED COMPUTER SYSTEM

Several activities occur in quality management which can be easily algorithmized. The source of quality data are all production process elements; all acquired quality-related data and records are collected, indexed, updated, stored and made available to authorized individuals. Production process elements are described by many features that may frequently change, and therefore require to be updated. For quality control purposes, a computer program has been installed, which serves for maintaining quality statistics and supervision on measuring equipment. In addition, work is performed on a database program with all laboratory-testing results.

The Quality Assurance System covers by its scope all stages of product realization. It starts from production planning in order to assure timely fulfillment of obligations resulting from contracts concluded with customers and covers all products offered by the steelworks, through the technical provision of the production process, the design of a new product range, purchases, the control of customer-supplied product, product realization, production follow-up activities, product traceability, to the control of measuring & testing equipment.

Ongoing quality diagnostics allows the assessment of raw-material suppliers using information from reports on the quality of supplied scrap batches. Thus, the quality management aspects commences at the receipt of scrap from the supplier on premises the steelworks'. The data from the report obtained from the supplier are entered to the system. After inspecting and weighing of the scrap, a correction to some data is made, which is done directly in the system.

The subject of documented procedures in Purchases are the supplies of all main and auxiliary raw-materials for the steel melting processes, such as:
- steel scrap,
- pig iron, ferroalloys,
- steel additions, and
- refractory mixtures and technological graphite electrodes.

Respective stages of production require quality inspection and testing, starting from the purchase of input materials from suppliers, through in-process quality inspection and testing, to the final inspection and testing and sale of the product to the customer. At each stage of quality inspection and testing, a lot of information concerning the features of materials, products and services is collected and should be filed.

The Quality Assurance System is continuously improved. Inspections and tests are monitored in the "Quality Control" module. Their purpose is to assure that the steelworks' products meet specified quality requirements. The planned and performed control activities comprise the factors shown in the schematic diagram (Figure 4.).

Inspection and testing results have the form of records and are archived in accordance with the adopted procedure "Quality Records". Its purpose is to assure that necessary quality records are created and stored in order to document the required quality of products and services and Quality Assurance System effectiveness.

The procedure covers all records required by the standard and is applicable in all the Steelworks' organizational units covered by the Quality Assurance System.

Inspection and testing activities have the form of procedures and instructions. An exception is in-process inspection activities performed by production personnel.

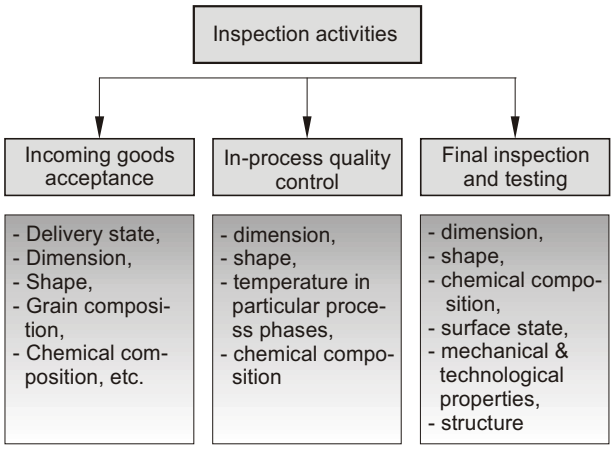

Figure 4. **General schematic diagram of control activities planned and carried out within the Quality Assurance System**
Slika 4. **Opći shematski dijagram kontrolnih radnji planiranih i provedenih bez sustava osiguranja kakvoće**

There are also inspection and testing activities carried out by independent personnel of the Quality Control and the LC Department, i.e. the Laboratory Department. The inspection and testing process can be presented in an integrated manner, as in Table 1.

Table 1. **Quality inspection and testing process**
Tablica 1. **Nadzor kakvoće i postupak testiranja**

Sub-process	Sub-process elements
Receiving, inspection and testing	Supplier qualification
	Inspection and testing
In-process inspection and testing	Testing the chemical composition and temperature of the steelmaking proces
	Inspection of the shape and dimensions in the steelmaking and rolling processes
	Testing of properties in the thermo-mechanical rolling process
Final inspection and testing	Inspection analysis of chemical composition Testing of physical and technological properties, and metallography Inspection of shape, dimension and surface
Inspection and testing of a new product range	Product certification inspection and testing. Inspection and testing of sample lots after reworking at the customer
Laboratory proficiency testing	Inter-laboratory tests Control of measuring & inspection equipment

The ISO quality standards of series 2000 permit that any information medium may be used with the integrated quality management system in an enterprise. The use of electronic method of transferring data is particularly required in enterprises, which already have the EBX integrated computer system available.

The electronic method of transferring manufactured product range-related data among all production units within an enterprise allows a far-reaching reduction of bureaucratic activities and much faster process-correction actions.

An example of a quality control scheme including the paths of information transfer between production departments, the quality control unit and the Management is shown in Figure 5.

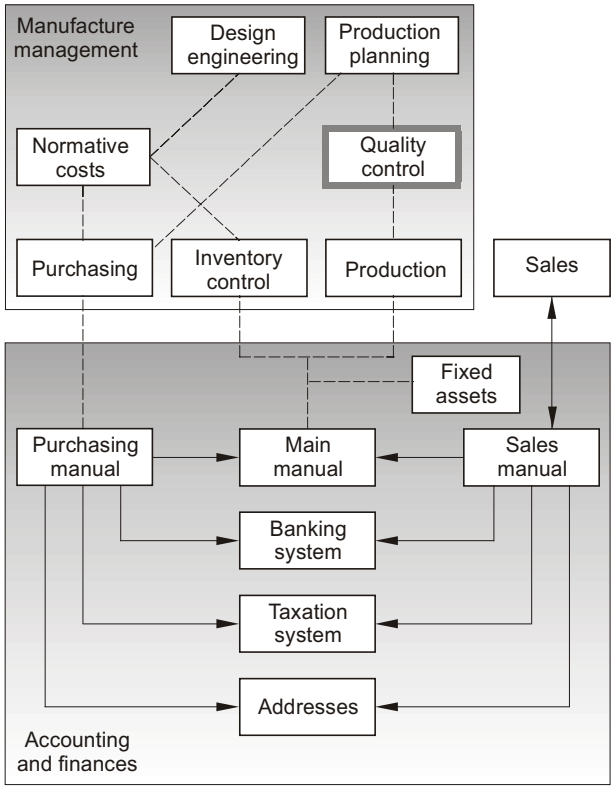

Figure 5. **Elements in the proposed EBX system solution**
Slika 5. **Elementi u predloženom rješenju sustava EBX**

The units shown in the organizational chart have been assigned actions that they may and should perform in the event of disclosing nonconformities (Figure 6.). The plotted directions of information flow indicate that either whole (solid line) or part (broken line) of information flows in a particular direction. Of particular importance is the inclusion of the analysis of costs related to internal rejects. A combined quantitative analysis of revealed nonconformities together with their assigned cost analysis represent the picture of expenditures incurred by the enterprise for their removal (not always a large number of a particular nonconformity causes the highest costs) Figure 6.

The present trends in enterprise management oriented to management through quality, as well as the fact of Poland's accessing the European Union, compel enterprises to perceive quality control in a comprehensive manner. A quality policy maintained by an enterprise should therefore, in addition to focusing only on the sole quality of

manufactured products, consider also the environmental impact of the production process carried out and care for Health & Safety conditions. Care for the natural environment was a foundation for creating legal bases regulating the rules of environmental loading according to the BAT criterion, which have been issued in the document BREF drawn up by the European Commission of IPPC in Seville.

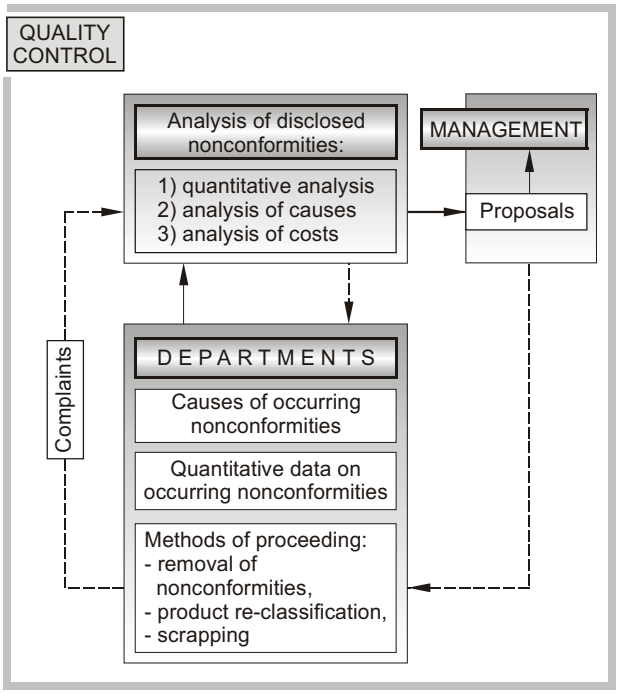

Figure 6. **Proposed solutions in the „Quality Control" module of the EBX system**
Slika 6. **Predložena rješenja u modulu „Quality Control" sustava EBX**

SUMMARY

The performed analysis of the management-aiding system in the steelworks has shown that the whole production sequence is not treated as continuous in the computer system. It is divided into three stages.

Each of these stages is treated as a separate module, i.e. there is information in the system on the index of material input to the steelmaking plant; when passing through the batch receiving, the billet is only known by this index, and after being processed on one of the rolling mills, it arrives at the finished product store with this index. Unfortunately, the whole material at the input through to the end of the process, where a finished product is obtained, is presented in the information system by this index only. Thus, individuals from beyond the production departments, where separate systems not integrated with the steelworks' information system function, are unable to find out on an ongoing basis using available data what is happening to the material that has entered the production.

Therefore, besides the extension of the whole system by the implementation of the additional module "Production", a "Quality Control" module should also be created. Also this module would be integrated with the functioning system.

In parallel with work on the introduction of an additional module, the production identification and marking system should be upgraded. The implementation of an electronic marking system (e.g. a barcode system) appears to be necessary, which will make the identification and positioning of a particular product in the production system much more efficient.

Owing to the possibility of using electronic readers, data on particular products can be entered directly to the management-aiding information system. An accurate ongoing identification would enable a detailed analysis of the quality of products. The implementation of an electronic identification system will make it possible to pick up nonconformities and defects as they occur.

This would eliminate the necessity of the ongoing entering of data for production reporting. At present, report databases are maintained based on the whole production cycle. There is a possibility of improving the accuracy of verifying storage or production inventories at a frequency of up to 4 to 5 hours. The whole system runs in real time, but reporting is done in a twofold manner. Reports are made in system applications or with a 24-hour delay. Once a day, they are read from applications, which causes their updating to be delayed by 24 hours.

The systemic approach do quality control in conformance with the TQM rules, including the assurance of the required quality of manufactured products, Health & Safety conditions and environmental impact, will enable the enterprise to create a complete system of management through quality.

In a quality management system, besides the strict control of finished products (with the aim to prevent products not meeting the standards and customer expectations from being issued to the market), internal control is equally important. The internal quality control system present at every stage of production, accomplished according to "Deming's Circle", enables and drives the continuous improvement of the manufactured product and, as a result, leads to the creation of a production cycle with a decreasing number of nonconformities.

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