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The synergy of the interaction of methods and tools of management on the technologies of material processes

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ABSTRACT

Purpose: The purpose of this monograph is to present a developed methodology of technology management with a particular focus on the specifics of heat treatment processes.

Design/methodology/approach: Researches on the solution of the problem in question required semantic definition of the contemporary range of technologies in the area of material realization of production processes, both in term of the classical approach to the issue of technology designing as well as in the statement of the problem in the context of the governance aspects. The paper concerns the analysis and research in the interdisciplinary field of materials science and management science.

Achievements: The main achievement relates to the design of technology management methodology that has been proposed so that it could be applied to a variety of manufacturing processes. Valuable and original results in both cognitive and application related terms to the determination of management technology have been obtained.

Research limitations/implications: Research and analysis, in spite of their interdisciplinary scope, have been limited to the process of technology management in the field of heat treatment processes, despite they had been considered as special processes. Due to the specificity of the issue, it is difficult to estimate the economic impact of the implementation of the proposed solutions.

Practical implications: The practical application of the proposed solution is related to the increasing demand for solutions concerning the application-type use of technology management by business entities to the production practice, but also this study is a starting point for further considerations and development of the scientific concept of technology management.

Originality/value: Presented in this paper author's opinion in the field of technology management, including the developed technology management methodology is an original approach of the subject. The priority factors in the field of technology management have been indicated. The concepts of technology assessment and technology management model have been proposed. It has been shown the legitimacy of the undertaken actions to determine the scientific issue of technology management, including the merits of practical use in manufacturing processes has been indicated.

Keywords: Management; Technology management; Process management; Knowledge management; System; Process; Special process; Heat treatment; Management system

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1. Introduction

The purpose of this monograph is to present the synergistic influence management on the material process technology. Based on the investigation results published over last of ten years [1-22]. The work is not detailed research methodology and made a presentation to general results of analyses of the impact of management synergies in the area of materials technology.

The overall objective of ongoing works is to present the arguments for the analysis in the study area and to create a methodology for technology management in the field of basic researches carried out under the materials and management science.

The specific objectives concerning the subject of the research i.e. the management of technology results from the general purpose of the paper:

a) formulation of a concept for the methodology of technology management,
b) application of the developed methodology in terms of the science of materials in the area of materials technology of heat treatment,
c) determination of the directions of future development of a theory in the field of technology management both in terms of materials processes and management, including a special range of technology design.

In order to achieve the purpose of the paper in terms of functionality, the topic in question has been analysed in terms of heat treatment processes due to its specific nature, and in particular, the acknowledgement thereof as special processes, both in terms of testing methodology and quality assessment function of its processes and resulting product properties, as well as in terms of the specific requirements for special processes in the field of management.

The developed methodology of technology management, based on the range of knowledge in the area of materials technological processes and management issues, including the management systems applied in production companies, is the goal of basic researches, which are at the interface of materials science and management science. The above, is one of the strategic goals of basic researches in the field of sciences under consideration.

The results of analyses and studies presented in the paper shall be also used to determine the direction of future development of materials engineering and production engineering, which is one of the main cognitive problems.

2. Topicality of the problem

The problem of developing a methodology of technology management relates directly the cognitive problem that pervades contemporary specialists in the field of materials engineering in the field of production processes quality management and management sciences [24,27,30,32,47,60].

A problem of establishing the requirements that should be fulfilled by the function of technology today in order to be considered for the faculty of science in the theory of materials engineering and the theory of production engineering (management) is becoming an actual issue.

The question that is being recalled more frequently in numerous publications is the issue concerning the adaptation of independent design methods for the needs of industry both in terms closely associated with manufacturing processes (processing of materials), as well as the production management processes, including technology design [24,26,27].

The methods of management and innovative manufacturing techniques are designed to increase the competitiveness of products and thereby of companies involved in production thereof. Opinions on this issue tend to indicate the existing criteria that affect both management and manufacturing techniques. They concern mainly the quality of the design (material, product, and technology) as well as business organizations in the context of the possibilities and advisability of implementation of the management methods and tools and improvement or implementation of new technologies. From the point of view of this paper, the author seeks to prove the thesis that modelling of technology management systems, is today the most important reason of the creation of competitive advantage, both in the short and long period of time.

Production management is inseparably connected to the history of industry, including one of the first processes carried out on an industrial scale – the blast furnace process, embedded in the field of materials engineering.

The concept of technological process is associated with production management and is inseparably linked with obtaining repeatability of processes which was initiated by American Eli Whitney (1765-1825) and some of his achievements relate to mass production of muskets. He was the first to mention the variability in the production process; next, in 1903, the British Standard Institution, largely in a scientific manner, meeting the expectations of buyers for the products of a certain quality led to the creation and registration of the British Standard Mark – which was later recognized as Kitemark – it was used on the tram rails confirming their quality and the activities carried out resulted in unification of the width of rails and reduction of their number from 75 to 5; Frederick W. Taylor (an inventor of HSS) and Karol Adamiecki (an author of the timing method) were next who applied the

scientific methods to the analysis and interpretation of the production process; another person who dealt with mass production was Henry Ford (a creator of the mobile production line). The foundations for statistical methods of process control gave Walter A. Shewart ("father" of statistical quality control) who developed the methodology of its implementation, which is invariably used in industrial practice since the 20th century. A significant contribution to the development of statistical methods has Polish scientists, namely Prof. Jan Oderfeld and Prof. Jan Obalski. In terms of quality testing of processes at the end of the 19th century a Mechanical Experimental Station was founded at the Technical University of Lviv, who led the forefront in terms of researches and evaluation of the quality of products. In terms of issues related to materials engineering in the 50s of the 20th century Prof. Fryderyk Staub was strongly involved in the field of normalization of steel. The above mentioned actions that had been taken by decades have a significant impact both in aspects of materials engineering and production engineering.

On the basis of the above, but also many other aspects of the development of manufacturing processes and their management in Europe and in the United States a method on specialization of technological processes had been created for decades. The opposite of this method was a production management model, developed in Japan, known as the "Toyota Production System – TPS", which focuses on a flexible response to changing demand within a group of relatively homogenous product. This system is suited for mass production of homogeneous products which may though be very complex in terms of their structure and technology. The above is developed by the Just in Time system and the concepts of Lean production, agile production and project management [17,52,53,60] respectively.

Technology is the backbone of any manufacturing process. It also forces the need of taking appropriate actions to seek hybrid solutions in the field of production engineering, materials engineering as well as mechanics and construction of machinery.

In recent decades, a significant progress has been made in the philosophy of thinking, principles, methods and tools used in the management sciences with a view to assist the company in meeting the requirements for products and manufacturing processes [51]. A wide range of formal and informal activities covers the entire life cycle of products. Used for years with the recognized in terms of their methodological level and valued for effectiveness methods and tools for managing that have been applied for many years, may be helpful in the process of improving the technology design. However, their introduction into industrial practice, including the assessment of their effectiveness raises a lot of controversy and they involve not significant interest in their use in industrial practice and the lack of integration of the use of their results [25].

Lack of strong interest in the implementation of new management methods, including the use of technological innovation in small and medium enterprises in particularly, results in significant differences in the efficiency and effectiveness of their actions. Derek Shledon defines these activities in the context of the implementation of the research in the following way: "Academic research on engineering design is having but a small impact on industrial design office/ new product development practice. Industry is not impressed by the plethora of research publications that have little influence on real competitive engineering" [61]. This causes a need for methods that use a scientific approach and those that have the greatest pragmatic importance for industry, with an emphasis on technology.

Coordination and integration of actions in terms of technology design, implementation of the manufacturing process with other processes operating in the company including management, have a significant impact on the efficiency and effectiveness of processes (in holistic terms). The element that integrates this area of activity may be technology management coordinated with the enterprise management system [22].

The organization of an enterprise includes interpenetrating processes with the master one, which is the production process, whose "backbone" is a technology.

Technology design is the ability to use technical and organizational knowledge, ability to perceive the relationship among: manufacturing techniques – material properties – expectations and requirements of the product – production engineering (management) [23,37-39,50,57].

Modern technology design must be, in a natural way, especially due to the dynamics of the processes, correlated in a synergistic manner with the management of the organization. Management of technology, including its design must be recognized as having a significant impact on the operations of the enterprise. Technology management is an area embedded in the project management, knowledge management, systems management, quality management and manufacturing techniques [50].

In industrial conditions, designing of new products and technologies is important for the implementation of the manufacturing process. These activities are closely linked with each other, and in the particular case in terms of product design, they can also affect the design of the material. Today, development in materials engineering is driving the product innovation hence technology innovation which can be exemplified by numerous papers

presented, for example on nanotubes, halloysite, hybrid materials, manufacturing techniques based on the implementation of complex processes in terms of physics of metals and chemical engineering [40-46].

The issue of technology management including its designing is based on the methods created for many years, management tools and systems approach, as well as methods of computer-aided design technology. Contribution to the analysis of the paper's subject, being the foundation of consideration of this subject adopted by the author and a complementary part thereof, are the results of analysis, studies and findings resulting from their implementation in the following areas:

- **system management:** the issue regarding the standards of management, their dynamic development and implementation into the industrial practice, including new emerging standards, methodologically based on the prototype of the management standards (family of ISO 9001 standards) but covering new areas, as well as increasing their specialization was included in the papers [1-4,11,12,16,18,19,22]. They relate in particular to the issues of specialization of management systems in the area of heat treatment processes. A part of the results of researches and analyses had practical application and the problem concerning the scope and details of management systems was named by the author as an "hourglass dilemma" in the management. The description of this issue is given in the works [4,22];
- **analysis of values in the manufacturing processes:** creation of the value in the production process and its analysis is an important issue not only theoretical but also practical in order to answer the question of effectiveness of both manufacturing technologies and organizational systems being applied. Works made by the author in this regard, confirm the significant impact of technology on the efficiency of the manufacturing processes and the research findings associated there with are shown in the works [5-8,17,22];
- **methods and tools of quality management:** the use of methods and tools of quality management in the production processes has certain reputation hence their direct association with the ability of application to technology management shows the values they bring, the results of researches on the application of methods and tools of quality management that are presented in the works [1,9,14-16,20,22] relate to demonstration of the potential impact of the methods and tools in a production process system control. Part of the test results has been implemented into industrial practice;
- **statistics in production management:** statistical test methods have special application in the field of production process control, the results of their application in manufacturing processes, and in particular concerning the design of the assembly process [14], or control the machining process [15] had practical application;
- **computer software tools:** computer-aided tools that are helpful, in particular, in the processes of designing of both the products and processes, have their recognized position. A special kind of tools for computer-aided design concerns the scope of aided design processes. An example of a practical solution of this problem in the design of heat treatment processes is given in the following works of the author [13,19,21,22]. Works on the development of the software are still in progress;
- **examination of the materials quality:** analysing the topics of quality in production processes, an area associated with the methodology of material researches cannot be overlooked. Also in this respect, the discussed subjects were presented by the author in [10-12,22], in particular focusing on the systematic of defects in the processes of heat treatment and diagnosis of their causes.

The usefulness of these tools is not subject to valuation, however many factors influence the effectiveness and efficiency of their impact on the structure of enterprises. The most important are:

in terms of the use of methods and tools of quality management in production, including technology:

- increase of the ability to adapt in the conditions of external variability;
- increase of the capacity to reduce the internal variability;
- continuous improvement of products and production under the control of production and benchmarking studies of both the products and manufacturing processes, including technology;
- the results of works of task groups ("quality circles"), acting in terms of design methodology;
- increasing the speed of response to market needs, including diagnosis of the directions of development of products and technologies;
- minimizing the manufacturing costs and optimizing the product quality as an action resulting from the application of appropriate management methods and tools;
- shortening the production time as a result of the implementation of modern management methods;

in terms of the use of management systems in production, including technology:

- increase of the adaptive capacity, in particular in the context of process management;

- continuous improvement of products and production to ensure the fulfilment of the emerging requirements not only in terms of law;
- cooperation with suppliers within an enlarged perspective of the processes – the production chains;
- organization of the production process/enterprise, designed to increase their effectiveness and efficiency;
- task groups ("quality circles") as a sign of commitment and concern of employees in the improvement of processes and products;
- development of appropriate distribution channels at the process input and output, increasing the response time to market needs;
- reduction of the production costs and improvement of the product quality by meeting the requirements of management systems in a formal way and taking care of the improvement of management methods as tools having a direct impact on the production process and technology;

in terms of internal and external factors influencing the potential of enterprises in the context of technology:

- employee's involvement/knowledge level (training, skills, competences);
- ability/adaptability in the field of the used know-how, knowledge management;
- continuous improvement of products and production, as a process of continuous modifications responsive to changes of customers' expectations;
- examination of market competition in terms of products and processes, the use of knowledge such as ongoing foresights;
- cooperation with suppliers, as well as cooperation in terms of joint creation of technology in the whole chain of production;
- the cost and quality of the product, manufacturing time regarded as the main indicators of the condition of companies.

3. The complexity of the problem and its analysis

The present paper as well as the results of numerous studies [1-20,22] relate to the problems of the issues correlating the impact of management sciences and materials science.

A paradigm of interpenetration of sciences and the search for synergies resulting from their merger is today a main direction of researches and constitutes a transition from mono-discipline sciences to the search and identification of the impact in the spino-disciplinary areas. It is also a requirement of engineering practice and a response to the industrial needs.

The present paper is an attempt to find the answer by presenting the example of developed methodology of technology management focused on usability in industrial practice in terms of its implementation.

The obtained results indicate significant problems in terms of management and the related demand for methods of designing and implementation of the product, including the implementation of the technology design process and technical and economic difficulties of the manufacturing process [60].

Technology is a special type of procedure, which is the result of the design process that depends on a number of criteria. In the present circumstances, two basic methods of designing can be distinguished:

- prescriptive methods (algorithmic, procedural),
- descriptive methods (cognitive, behavioural).

Prescriptive methods for operational purposes must take the highly specialized form, which means that they lose the value of generality. "Soft" methods are advantageous as tools of significant usefulness in problematic situations.

The aim of the studies is therefore to design methodology having a significant and objective use in real problematic situations oriented to the use of sources of knowledge, broadening experience and an effective and efficient problem solving methods.

The problems which are encountered in terms of technology design and thus result in forming the technology management paradigms apply to [23,26,29,31,33-36,39]:

- duration of the project (which is nowadays expected to be shortened to a minimum since it also influences the business advantage of an enterprises),
- lack of procedural approach to debugging issue at the design stage, including such activities as projects evaluation,
- lack of projects improvement as a result of feedback of both the results of monitoring analyses and production measurement and of the so-called "customer's voice",
- lack of the shaped system solutions for cooperation between designers and production, including marketing services.

The quality of technology designing has a major impact on the outcome of the production process, hence the attention to the process of technology designing seems to be a source of advantage that allows companies to build their business strategy.

Implementation of management systems in an enterprise based on ISO standards, Technical Specifications – TS,

Publicly Available Specification – PAS promotes the use of different solutions for the manufacturing process. Although a direct reference to technology is not visible therein, but correct interpretation of these requirements allows strong correlation in this regard. Nowadays, the requirements given in a factory Production Control Standard are most corresponding in this regard.

The scope of activities relating to technology designing is very rich nowadays and concerns [48,49,51,54-56,58-60]:

- prototype researches,
- value analysis, benchmarking,
- projects evaluation,
- R&D, patents,
- statistical process control (SPC),
- analysis of production costs combined with material selection,
- computer simulation methods,
- analysis methods of customers' needs,
- design for production, concurrent designing,
- planning and dynamic scheduling,
- the use of methods: FMEA and DFA, rapid prototyping, ABC analysis, objectives tree, decision matrix, QFD, DOE, FTA, Taguchi method,
- an approach according to Lean management, Lean production methodology,
- Kaizen methodology,

all of the above mentioned activities are a part of the issue of technology management and constitute a factor shaping the market success of an enterprise – Figure 1.

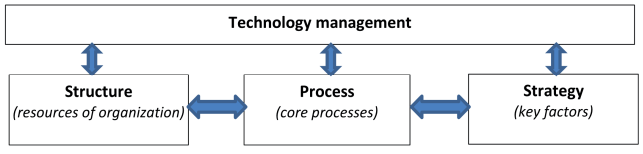

Fig. 1. Relations of strategies, processes and structure as the foundations of technology management

However, the impact of technology management on the business success of an enterprise cannot be clearly identified. It depends on the synergistic interaction of many organizational factors and development of manufacturing and materials engineering.

The goal of methods used in the technology management is to determine the optimal use of the material, the optimal form of a construction, the optimal technology, which should be directly translated into the business goals of the enterprise.

The modern conception of the manufacturing process must be based on the search for the influence synergy of an approach based on processing of material objects, as well as through the perspective of broadly defined management actions – Figure 2.

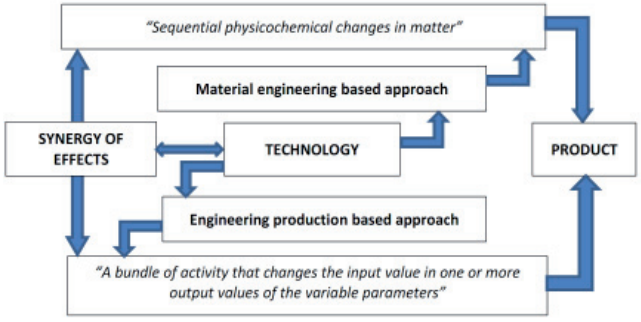

Fig. 2. Model of interactions in terms of technology of material processes

4. Risk in technology assessment as a way to measure the impact of management on technologies of materials processes

An issue of technology management and development of methodology in this regard is related to the achievement of the overriding objective being set – an increase of efficiency of the organization of production processes.

A methodology of technology management has been developed for technology management methodology determined in such a way – Figure 3.

The developed methodology is based on a combination of the two major issues of the modern approach to production processes: innovation and management. The proposed technology management methodology is based on carried out analysis and research on issues of evaluation of requirements for the management standards and their impact on modern manufacturing processes, the quality assurance issues in manufacturing processes, quality control issues in manufacturing processes, which have been shown in details in [22].

The developed technology management methodology is based on the systems management requirements operating in real terms as well as on the methods and tools of quality management.

Technology management methodology is based on using the developed original concepts [22]:

- Technology Risk Analysis,
- Analysis of Technology Critical Areas,
- Analysis of Technological Process Documentation.

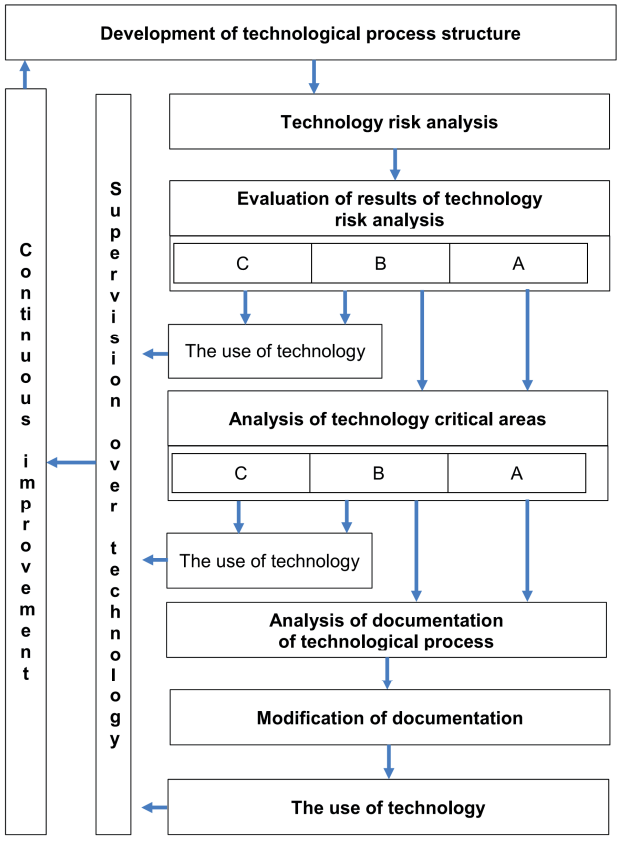

Fig. 3. Methodology of technology management [22] (symbols: A, B, C – level of technology risk, level of technology criticality)

The proposed technology management methodology is applied to:

- for newly designed technological processes,
- for technological processes modified in terms of the structure of operation, types of machinery and equipment, execution parameters of operations, customer requirements, supplier requirements, procedures and internal guidelines, legal and system requirements, control system, methods of research.

In terms of implementation of the management technology the enterprises should take the following actions:

- first stage: formulate a strategy for technology management, establish the criteria and objectives including details on the scope and values proposed in the various concepts of technology management methodology, establish a procedure for technology management,
- second stage: carry out an analysis of technological processes based on the proposed methodology,
- third stage: evaluate the results obtained in terms of technology management,
- fourth stage: analyse and verify the applicable technical documentation, archiving methods and the use of information resources on processes, the applied quality management methods,
- fifth stage: carry out an audit in terms of the technological process(-s) management and take improvement actions.

The suitability of the proposed technology management model in terms of practical application significantly is determined by an individual approach and the method of implementation in a given enterprise. Limitations associated with the use of the developed technology management methodology concern [22]:

- the technology risk assessment issues – methods of determination of the function criteria (unless modified) and definition of ranges for particular levels of technology risk;
- the issues of evaluation of critical areas of technology – methods of determination for each level of technology criticality of the scope of methods and tools of quality management applied in practice in an enterprise. Such assignment may be based on general assumptions for the whole enterprise, but also can be preceded by an analysis and conclusions for each technology separately. The solution to this problem should be determined in technology management procedure. The mode and method of verification of the applied methods and tools, particularly at the "B" and "A" level of technology criticality should be also defined to confirm the validity of their application;
- the issues of technological documentation management – methods of determination of the structure of documents used in an enterprise in a multifaceted range preceded by a detailed analysis of the requirements, including the introduced changes. The method of validation and verification of documents with regard to the status of their validity resulting from the analysis must be also determined.

Reliability of performance of analyses in accordance with the model proposed in the technology management methodology should allow to obtain high efficiency in terms of technology management in particular in terms of the adequacy of the applied methods and tools of quality management and the scope of applicable documentation and to reduce the risks associated with the applied technology.

The placement of technology management in quality management system is related to the development of technology management procedures the scope of which

shall include the required individualized issues presented above, constitutes a restriction related to the full implementation of the presented methodology to practice.

The dynamics of development in creation of new technologies, shortening their life cycle, and therefore the products life cycle must be based on properly planned and implemented strategies for the technology management. This defines the importance of technology management issues undertaken in the present paper as an aspect complementary to the objectives of designing of manufacturing processes and organization management. Having a technology that is considered as a component creating a competitive advantage is equally important to adequate management thereof in order to achieve the assumed indicators of effectiveness and efficiency for the technology being assumed.

In the context of the carried out analyses and developed technology management model, a general model of technology management as a subsystem of the quality management has been presented in the Figure 4 below.

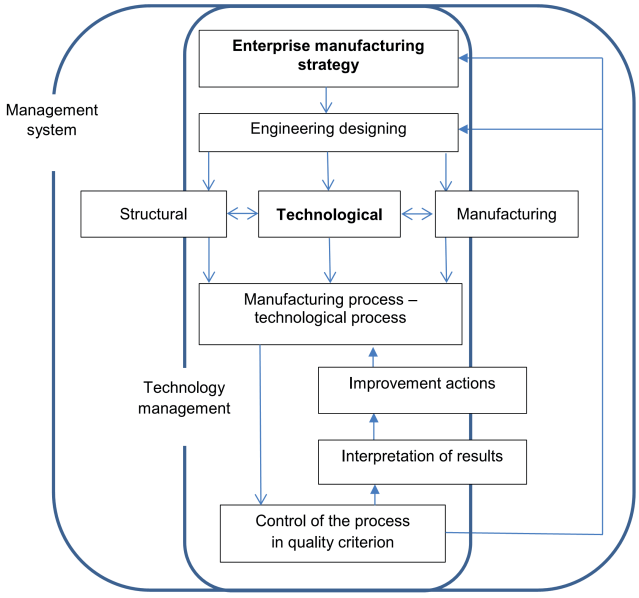

Fig. 4. Technology management as a subsystem of quality management [22]

The concept of technology management that has been presented in this paper allows, in a pragmatic way, to focus on technological processes however not in isolation from the real conditions and the related restrictions. Systematic monitoring and supervision of the applied technologies allows elimination of all possible disturbing symptoms affecting both the micro-and macro-economic scale of enterprises.

The technology underpinning the creation of an added value must itself be subject to variability analysis processes including in particular the tendency to evolve changes thereof in essential range of formation of the desired quality of the products. This should be by all means considered as the system action, hence resulting in a need to regulate the system approach in this regard.

Technology management concept focuses on the production process and in particular on its essential part concerning the objectivity of the process – technology, which is the foundation of the search for the advantage in terms of competitiveness.

The studies on literature and researches in the field of enterprises implementing the manufacturing processes indicate the need for exploration of the issues discussed in this paper, and thus it seems desirable to develop scientific recommendations for the practical implementation of issues of technology management in manufacturing enterprises.

The issue of technology management applies to all enterprises, here in the context of the solutions proposed in the paper, and is in particular dedicated to small and medium-sized enterprises, since these organizations have limited resources to create fully personalized and modern R&D centres. A pragmatic approach to the implementation and execution of technology management in the field of methodology of technology management in organizations belonging to the so-called group of small and medium-sized enterprises, which has been presented in this paper, is able to increase both their effectiveness and efficiency of the carried out processes.

5. Summary

The methodology of technology management and its implementation in industrial practice is a bridge connecting the aspects of material technology engineering with aspects of management.

Implementation of the process approach in enterprises that has been postulated since 2000 and based on improvement and innovations is one of the main premises for the modern creation of the enterprise strategy. Innovation in technology is using the potential gap in the operation of processes and the improvement is focused on increasing the functionality of the processes being carried out.

The proposed methodology indicates an important and relevant issue of equal treatment of the operational strategy of the company's activity and its long-term business strategy, there also in the issue of establishing the priorities for technology.

The methodology developed in today's conditions of manufacturing enterprises will not affect the disruption of the process since its implementation should be the result of determining the appropriate procedures that take full advantage of the synergistic system of the subjective use of technical, material and management resources.

It should be noted that the proposed methodology of technology management is based on object-neutral approach and its practical implementation into the industrial practice will provide a thought-out structure of operational activities within the scope of a specific framework methodology of technology management using, to a significant extent, methods and tools and management systems with significant influence on the development of enterprise technology in the course of continuous evolutionary changes. A significant contribution in the field of materials science is the implementation of problem-dependent methods and tools in the field of management sciences and identifying the significant synergistic interactions. The development of technology management issues is related on the strategic level with the creation of the mechanisms of an increase of implementation of innovative technologies applications oriented researches. Technology is, together with the knowledge, the most profitable product, which is however threatened by a lack or distortion of the mechanisms of commercialization.

In terms of the operational use of the developed methodology of technology management for the evolution of issues in the perspective of the next decade, the following directions and areas for action are expected to be developed and established [22]:

- use of information from the completed projects of technology and creation of centres of technology management mainly in small and medium-sized enterprises in order to create their competitiveness,
- creation of management subsystems designed to create mechanisms for implementation of new technologies along with the search for solutions to standardize the implementation at the stage of their design; it is expected in this regard to create computer-aided building tools allowing simplification of planned and ongoing activities in this area,
- development of integrated methods of technology assessment, in particular in terms of issues concerning their flexibility, variability, similarities and economy,
- implementation of the used and new management methods and tools to enhance the effectiveness of technology management with a high potential of forecasting especially in the area of combining the requirements for product properties and process parameters,
- the use of artificial intelligence methods, including in the field of neural networks and fuzzy logic methods in the design of technological processes in the criterion of the quality of products,
- undertaking actions in the process of implementation of technology management methods and tools aimed at the development of a high level of quality of products through the quality control of technology design, including an approach based on the project management,
- implementation of value-added analysis to evaluate technology as an objective tool of simulation of technology development supporting the technology management and embedded in economics of processes,
- construction in terms of technology management of mechanisms for efficient and effective use of overt and covert knowledge in the designing and enhancement process,
- development and implementation of effective methods and tools for technology documentation management is an integral part of the constructed centres of knowledge,
- creation of managerial awareness and practical methods of knowledge application in the field of technology management as a complementary range of skills of the modern technologist,
- intensification of the use of concurrent engineering formula in technology management, including implementation of quality management methods and tools for the evaluation, verification and validation of the proposed processes and products,
- development of legal protection issues in the aspects of practical applications in the field of technology management mechanisms applied in enterprises,
- creation of an integrated technology management based on multi-faceted requirements concerning responsibility for sustainable development, safety at work and social responsibility,
- improvement of methods of organizational approach to technology management including the areas of technology mapping,
- development and use of technological foresight methods, as recently recognized method of development forecasting,
- creation and participation in technology transfer networks including the area for searching the synergistic solutions of technologies,
- search for correlations and determination of methodology for the impact of the strategy of the planned product aging (planned obsolescence) on the management of technology,

- use of technology management as a tool for activity development and business initiative in terms of resource management, including direct impacts on the structure, as shown in the paper, of material manufacturing processes.

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