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USE OF THE SYSTEMIC APPROACH IN STUDYING THE INDUSTRIAL PROCESSES

BY

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Abstract. One of the methods used to develop theoretical investigations in the scientific research is the systemic analysis. The purpose of the research presented in the paper was to develop an analysis of various ways of systemic approaching certain subjects of scientific research interest and to find suggestive ways of illustrating them. The investigation of the reliability that corresponds to certain computer subsystems, of the end milling process of test pieces made of cast irons, of the behaviour of the conical peaks under the action of the electrical discharges, and of the chemical engraving process was taken into consideration. The theoretical analysis of the principles of the systemic approach allowed considering the above-mentioned processes or phenomena as systems. In this way, a better image concerning the subsequent development of the additional theoretical and experimental research of the considered processes or phenomena was obtained.

Keywords: systemic approach; industrial processes; computers subsystem degradation; end milling; electrical discharge; chemical engraving.

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1. Introduction

The systemic approach of the industrial processes or phenomena aims to consider such processes as systems with input factors and output parameters.

The presentation was based on the identification of the distinct ways of systemic approaching and developing of such an approaching in the cases of some industrial processes or phenomena.

The systemic approach is a theoretical analysis method that aims to consider the investigated organization, product or process as a system including at least input factors and output parameters. It is considered that a system is composed of interdependent and interactive subsystems or items that form a unifying whole (Băloiu and Frăsineanu, 2001; Chihaia *et al*., 1999; Eykhoff, 1977; Pascu, 2004; Slătineanu, 2019).

It can appreciate that in contrast with the analytic approach, essentially the systemic has the capacity to unify and concentrate the investigation on the interaction between components, to emphasize the interactions effects, to simultaneously change the groups of variables, to consider the knowledge of goals and fuzzy details, to act through objectives (de Rosnay, 1997).

A comparison of the analytic approaches with the systemic approaches was developed by J. de Rosnay (1997).

Over the times, the researchers proposed various ways to interpret and graphical represent the systemic approach.

Thus, aiming to elaborate some recommendations for an adequate approach of the disasters and management crises generated by them, Guntzburg and Pauchant (2014) developed an analysis of the Fukushima nuclear disaster. They concluded that changes inclusively in human resource management and training must be made.

Behrends *et al*. took into consideration the autofagy as a system and elaborated complex graphical representations able to highlight a real interaction network (2010).

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2. The Systemic Approach of the Process of Computer Subsystems Degradation

The computer system is considered today as an indispensable tool for many activities. If initially the computer had a relatively simple structure, taking into consideration the increased number of problems that could be solved by means of the computer, additional components were gradually added to the computer system. One the other hand, as a consequence of its intense use, over time the computer subsystems are affected by a lent or faster degradation

process. To ensure a long service time use and to optimize the computer subsystem operating conditions, one could take into consideration the degradation process as a system. A graphical representation that corresponds to the approaching of the computer system degradation process is presented in Fig. 1.

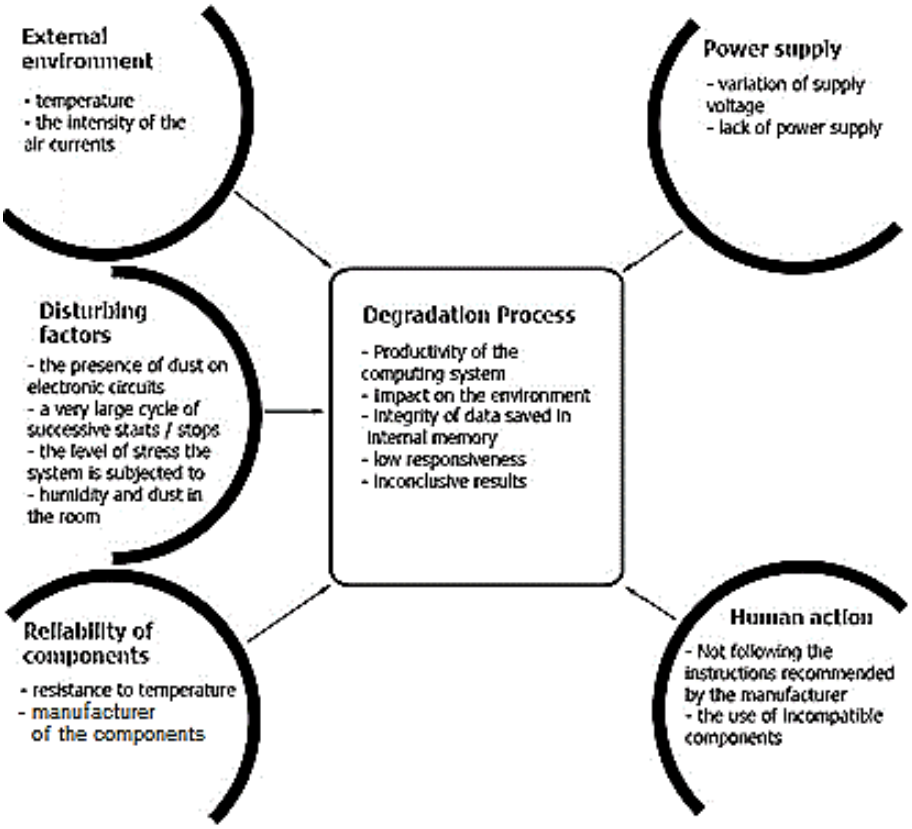

Fig. 1 – Graphical representation that corresponds to the systemic approach of the computer subsystems degradation process.

It can observe that as the main input degradation process factors, the external environment, the power supply, the reliability of the components and the human action can be considered; it also was appreciated that some disturbing factors could affect the values of the output parameters.

An idea of deeper investigation of the process of computer subsystem degradation was to design and develop equipment able to facilitate the analysis of the process, taking into consideration the possible operating of the system in less favourable conditions. In this way, a schematic equipment representation was conceived (Fig. 2). It can see that following the graphical representation content, there is the intention to evaluate the computer operating performances

in less favourable conditions generated, for example, by changing the operating temperature, the presence of the air currents and the dust deposition on the components, etc.

3. The Systemic Approach of the End Milling Process Applied to Cast Irons

The end milling is used frequently to obtain flat surfaces of the metallic parts. Essentially, the end milling process supposes the rotation of a tool that has many cutting edges, while the workpiece achieves a feed motion in a plane perpendicular to the tool rotation axis.

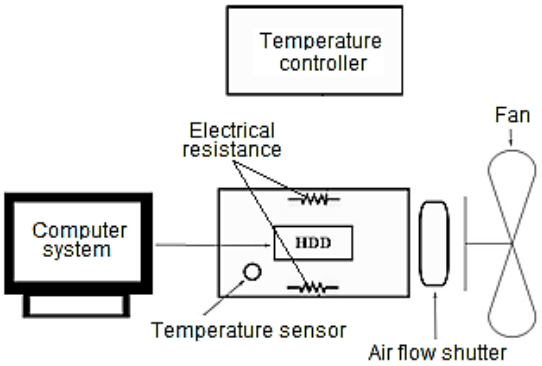

Fig. 2 – Schematic representation of equipment for studying the computer system performances in less favourable conditions.

The process could be evaluated by means of some process output factors, as the material removal rate, machining accuracy, surface roughness, thickness of the surface layer affected by the machining process, tool wear and machining cost.

Various groups of factors are able to affect the values of the process output factors: cutting conditions, properties of the workpiece material and the tool material, geometry of the tool active zone, stability of the technological system, etc. To develop a systemic approach of the end milling process, the graphical representation from Fig. 3 was proposed. In this graphical representation, the main process input factors included in the above-mentioned groups were considered.

The analysis showed that some of the input factors of the end milling process are able to affect especially the values of certain process output parameters and this fact was highlighted in Fig. 3.

To develop an experimental research concerning the influence of some process input factors on the sizes of the considered process output parameters, the schematically representation from Fig. 4 was also elaborated.

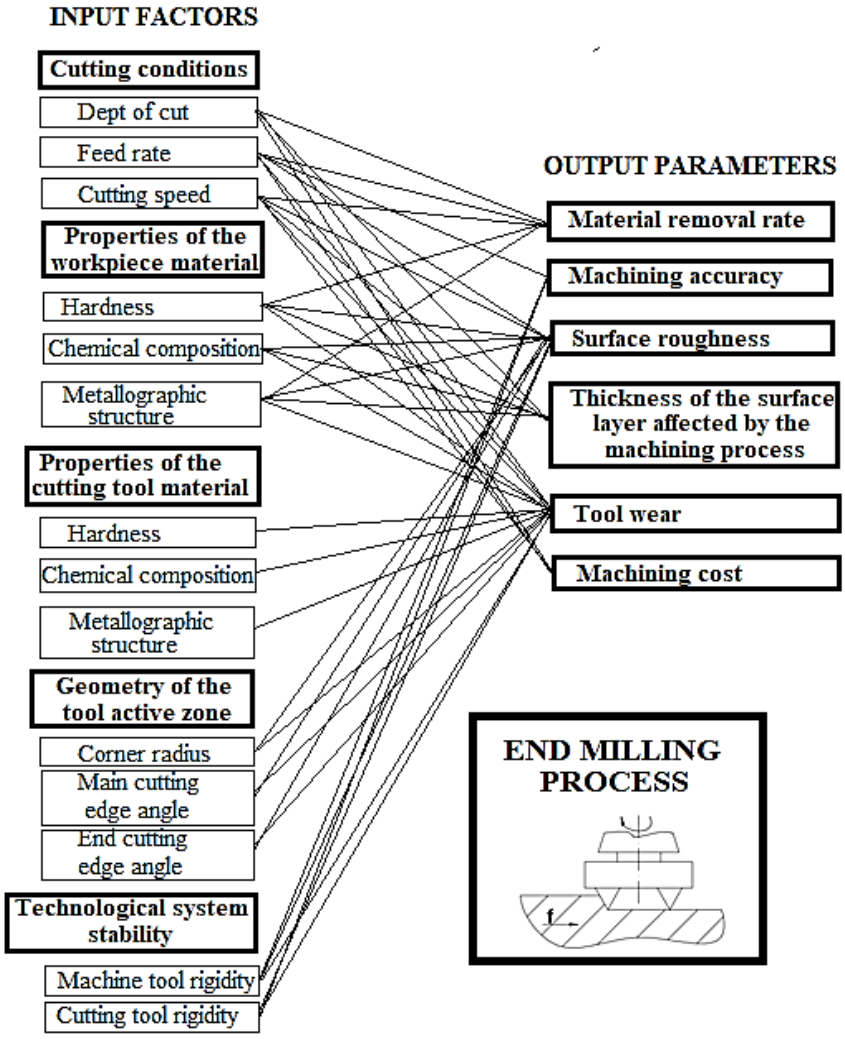

Fig. 3 – Graphical representation that corresponds to the systemic approach of the end milling process.

4. The Systemic Approach of the Conical Peaks' Behaviour under the Action of the Electrical Discharges

The electrical discharge machining is a nonconventional machining method based on the developing electrical discharges between the closest asperities that exist on the tool electrode active surface and the workpiece surface to be machined and along a trajectory that correspond to the minimum electrical resistance between the electrodes involved in the machining process.

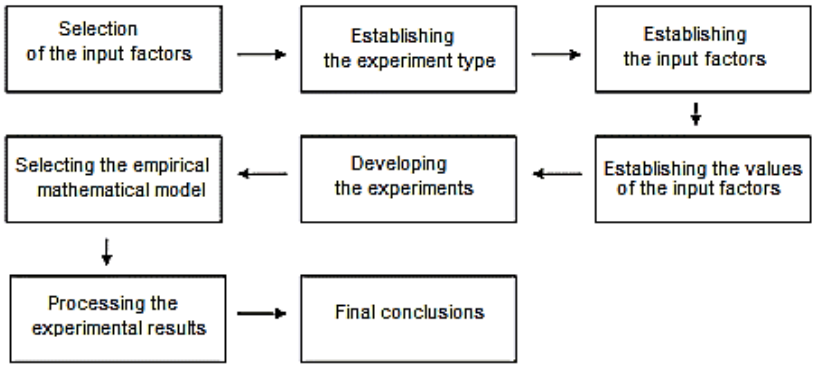

Fig. 4 – Schematic representation of the stages necessary in development of an experimental research concerning the influence exerted by some process input factors on the values of the output parameters.

If the intensity of the electric current that corresponds to the electrical discharges is high enough, small quantities of the electrodes materials are melted and even vaporized. These small quantities of material detached from the electrodes could arrive in the work gap, from where the circulation of a dielectric fluid determines their removal from the work zone. From the point of view of parameters of technological interest in the case of the electrical discharge machining, it is important that the quantity of material removed from the workpiece be maximum, since such an effect ensures the increase of the material removal rate.

It was supposed that the effects of the electrical discharges could depend on the asperities' shapes and on the kind of the electrodes' materials. It was appreciated that the above-mentioned effect could be investigated by developing electrical discharges between a test piece that presents a conical zone and the plane surface of the tool electrode. To develop an experimental research aiming at highlighting such effects, a systemic analysis was developed (Fig. 5). The main process input factors could be the voltage between the electrodes, the capacity of the capacitors included in the electrical discharge circuit, the thermal properties of the electrodes' materials and the angle of the test piece conical zones. As measurable output parameters, the diminishing of the electrodes' masses, the test samples lengths, and the size of the heat-affected zones were taken into consideration.

5. The Systemic Approach of the Chemical Engraving Process

The chemical machining is a nonconventional machining method of material removal from the workpiece as a consequence of the chemical reactions developed between the workpiece surface to be machined and a

chemically active substance. The chemical reactions are determined by the difference of electrochemical potentials that exist between the distinct zones of the workpiece material or between these zones and the substances included in the chemical active liquid. Only rarely the gases are used as chemical active substances. The fluid character of the chemically active substance facilitates the immediate removal of the chemical reactions products from the work zone.

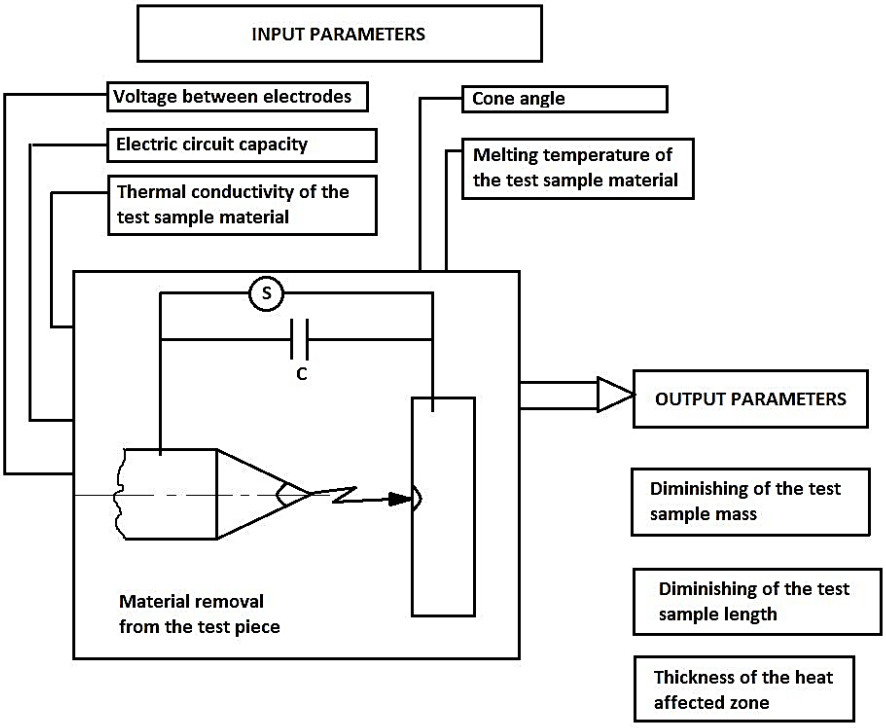

Fig. 5 – Schematic representation that corresponds to the systemic approach of the conical peaks' behaviour under the action of the electrical discharges.

In the case of the chemical engraving, the reactions are developed in strict coordinated zones, and thus inscriptions of reliefs of low heights are generated on the workpiece surface.

Since there was the intention to develop an experimental research concerning the factors able to affect the results of the chemical engraving, a systemic analysis of this process was achieved (Fig. 6). The analysis showed that the main input factors of the chemical engraving process could be the physical-chemical properties of the test sample and of the chemically active substance, roughness of the workpiece initial surface, way of chemically active substance circulation in the work zone, temperature of the chemically active substance, process duration, etc. As main output parameters of the

chemical engraving process, the material removal rate, roughness of the machined surface, engraving accuracy, wear level of the chemically active substance, thickness of the possible affected surface layer were taken into consideration.

On the base of the systemic analysis, simple equipment was defined to develop an experimental research in the future. The main components of this equipment could be the recipient where the engraving process will develop, the subsystem of placing and clamping the test piece, the eventual subsystem of circulation of the chemically active substance, the subsystems for measuring the temperature and the pH of the chemically active surface, etc.

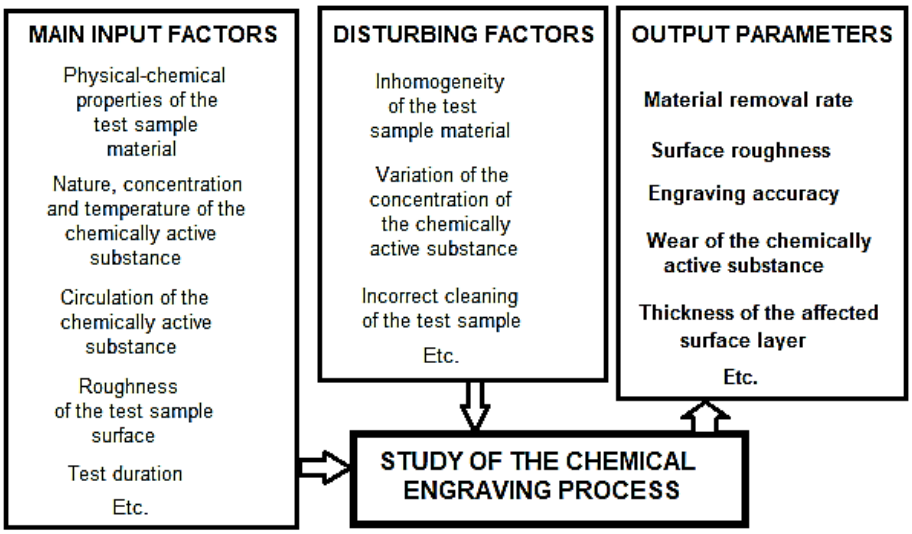

Fig. 6 – Schematic representation that corresponds to the systemic approach of the chemical engraving process.

6. Conclusions

The systemic analysis is a theoretical analysis method that considers the investigated process, phenomenon, equipment or equipment component as a system with input factors, output parameters and possible disturbing factors. Various ways of graphically representing a system when applying the systemic analysis were identified. To develop an experimental research in the field of some industrial processes in the future, systemic analyses were developed for each of the considered processes and using distinct ways of their graphical representations. The processes investigated by means of the systemic analysis were the degradation of the computer subsystems in certain experimental conditions, the milling process applied to the test samples made

of cast iron, the behaviour of the conical surfaces affected by the electrical discharges, the chemical engraving of the metallic test samples. The analysis facilitated the better identification and highlighting of the processes input factors and output parameters. It was also taken in consideration the possible influences exerted by the disturbing factors on the results of the investigated process. It was noticed that there is also the possibility to supplementary highlight the correlation between the process input factors and the output parameters. In such a case, the graphical representation is more complex, but it facilitates a better explanation of the correlations possible to exist between the process input factors and the output parameters. Another advantage of the last way of the graphical representation of the systemic analysis results was constituted sometimes by its possible suggestions of theoretical modelling of the investigated process. In the future, there is the intention to develop a deep theoretical investigation and experimental research of the considered processes.

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UTILIZAREA ABORDĂRII SISTEMICE ÎN STUDIEREA PROCESELOR INDUSTRIALE

(Rezumat)

Una dintre metodele utilizate pentru dezvoltarea investigațiilor teoretice în cercetarea științifică este analiza sistemică. Scopul cercetării prezentate în lucrare a fost

de a dezvolta o analiză a diferitelor moduri de abordare sistemică a anumitor subiecte de interes în cercetarea științifică și de a găsi modalități sugestive de ilustrare a lor. A fost luată în considerare investigarea fiabilității corespunzătoare anumitor subsisteme ale calculatoarelor, a procesului de frezare frontală a epruvetelor din fontă, a comportării vârfurilor conice sub acțiunea descărcărilor electrice și a procesului de gravare chimică. Analiza teoretică a principiilor abordării sistemice a permis considerarea proceselor sau fenomenelor menționate mai sus ca sisteme. În acest fel, s-a obținut o imagine mai bună privind dezvoltarea ulterioară a cercetării teoretice și experimentale suplimentare a proceselor sau fenomenelor luate în considerație.