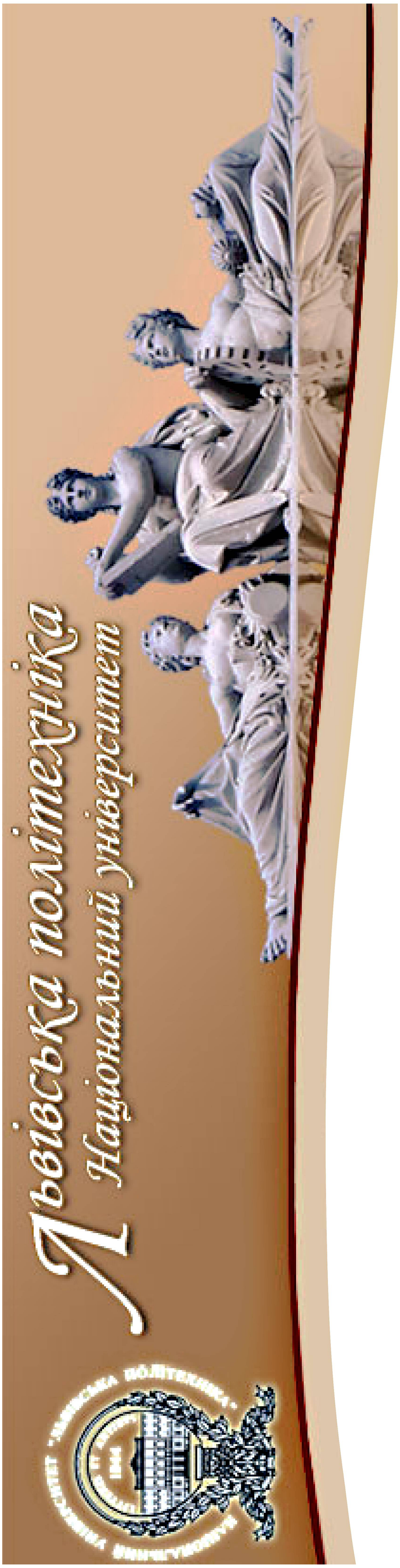

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“Львівська політехніка”

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GRINDING SYSTEM MODELLING AND SIMULATION

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In accordance with the Systems Engineering (theory of technical systems) one of the important initial stages of a system development is an adequate representation of the system from the concept stage to the running one. The system design includes its description, modelling and simulation, which may be represented in the respective formats: verbal description (text) in ordinary languages, graphical representations (block diagram, graphs), special signs systems (e.g., programming languages), mathematical model, a timing diagram, the combined method, etc. Selecting an appropriate way of the system representation depends on the purpose of the study. If the purpose is to create conditions to ensure the desired course of a process, when the process is the developing system, then it should be said of the system operation and control algorithms. In this case the technical system is being developed in the form of a control system model. In this modelling (versus simulation) the system is a mathematical abstraction that is taken as a model of a dynamic phenomenon which represents the dynamic phenomenon in terms of mathematical relations. According to

H. Freeman [1] such a system is characterized by the input ***u***, state ***x*** and output ***y*** (Fig.1, *a*).

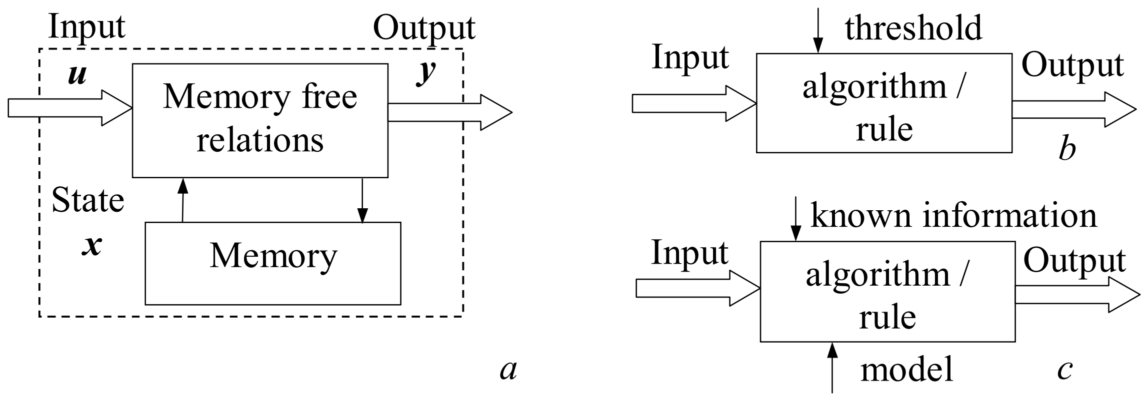

Fig.1 – Representation of the grinding system based on "input-state-output" model (a) [1] and those for decision making without (b) and with (c) a model [2]

The input ***u*** in the form of a set of time functions (e.g., in time domain) is the external forces (input variables) which are acting upon the grinding process that represents the dynamic phenomenon mentioned. The state ***x*** is a form of the system state-space representation, which with the input affects the output ***y***. The output ***y*** in similar form is the measures of the grinding process result, i.e. output quantities belonging to the ground part (part accuracy, surface finish and surface integrity).

A basic characteristic of any dynamic phenomenon is its behavior at any time and whether or not the behavior is traceable not only to the presently applied forces (input variables) but also to those applied in the past. A dynamic phenomenon (process) may or may not possess a memory depending on whether or not the effect of past applied forces is stored. In this connection the state ***x*** of the system is a vector function of time (e.g., in time domain) as well as both the input ***u*** and output ***y***. In grinding it may be corresponding signals like those of grinding forces ***F*** in Newtons, temperature ***T*** in Celsius or acoustic emission ***AE*** in RMS quantities.

Similarly, the system approach have been taken by H.K. Tönshoff et al [2] to explain a strategy of decision making while interpreting a process monitoring in grinding without (Fig.1, *b*) and with (Fig.1, *c*) a process model. There are two approaches for the decision making. Firstly, the distinctive values of the processed signals are to be compared with a predetermined threshold in order to identify the status of the grinding process by means of preparing a process database (memory stored). This approach is the preferred choice for sensor signals used to interpret output quantities. Secondly, a model based identification approach may be when various kinds of physical or empirical models are employed which utilize known relationships (Fig.1, *c*). As a result, the calculated value is compared with a threshold in order to evaluate the process. This approach is the preferred choice for the sensor signals used to monitor the process quantities which are equal to the system state

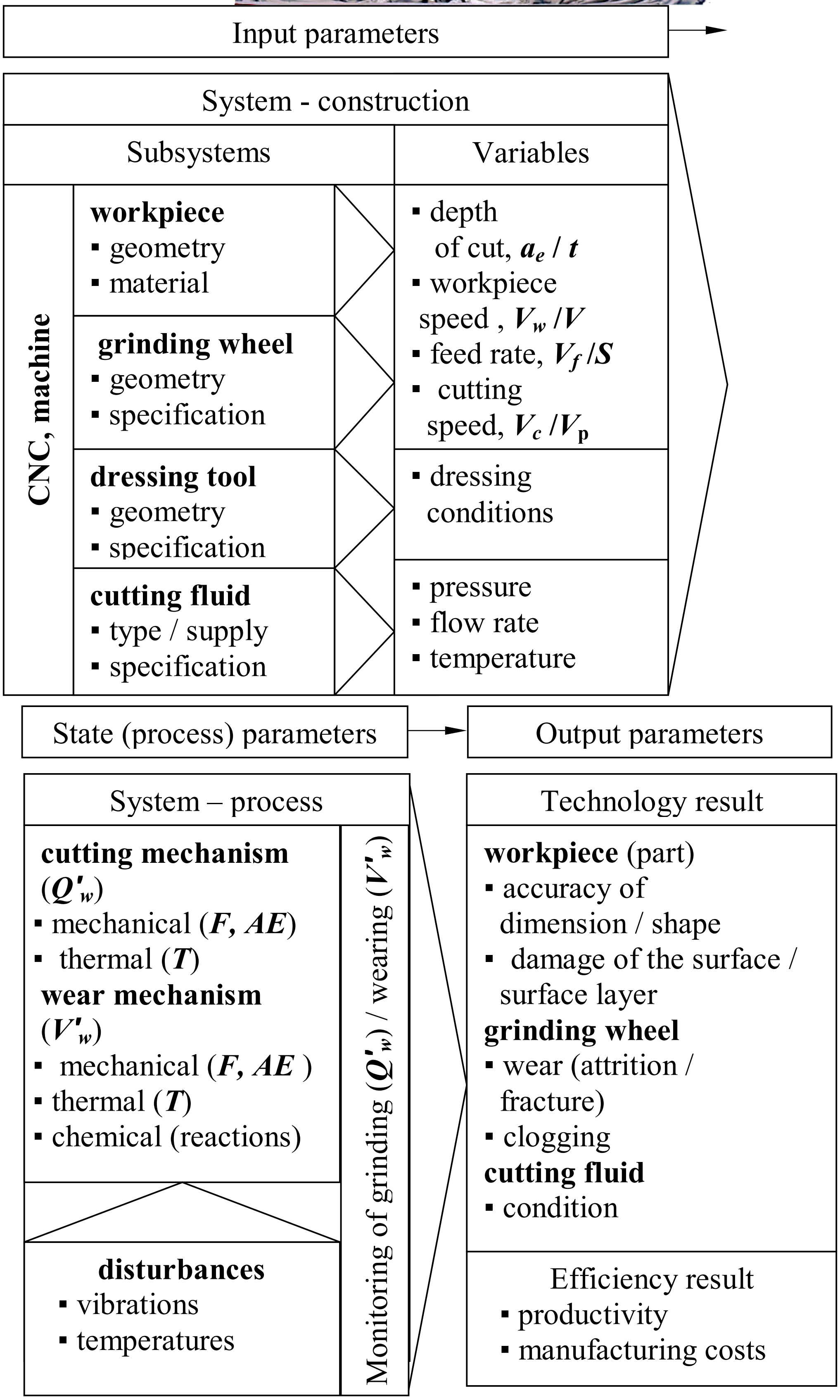

Fig.2 – Grinding system model (in fractional notations the input variables are listed in overseas [3] and domestic designations)

ones. Because of its complexity and significance, the model based identification approach involves understanding the process model (don't confuse with the grinding system model). In this connection the methods for process modelling are of great impotence as they are in decision making.

Methods for process modelling discussed further. Besides the model definition mentioned above another term to explain 'model' may be as follows: a model is the abstract representation of a manufacturing process which serves to link causes and effects [2]. That is why the description of the correlation of different quantities of a real system to correspond to a modeled system is the dominant task of process models. In grinding, the dependences of settings on process quantities such as grinding forces $\boldsymbol{F}$, temperature $\boldsymbol{T}$, and acoustic emission $\boldsymbol{AE}$ as well as on output quantities such as surface roughness and surface integrity (surface layer quality like grinding burns and residual stresses) may be mapped too on the basis of F. Klocke' representation [3]. Taking into account this representation, a model of technological grinding system can be represented as follows (Fig. 2). The model consists of the following state parameters: $\boldsymbol{Q'_w}$, $\boldsymbol{V'_w}$, $\boldsymbol{F}$, $\boldsymbol{T}$, $\boldsymbol{AE}$, where $\boldsymbol{Q'_w}$ is the specific material removal rate in $mm^3/(s\cdot mm)$, $\boldsymbol{V'_w}$ is the specific material removal in mm^3/mm.

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MANUFACTURING TECHNOLOGY AND PROPERTIES WEARFIRMNESS TERMITE CAST IRON

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Introduction. That is why the synthesis of materials on the basis of metallothermic processes as well as the investigation of the influence of new technological methods of getting metal on microstructure, chemical composition, mechanical properties of manufactured castings got great practical importance. Metallothermic reactions further and further become of great appliance in science and technology. Under the lack of energetic and raw basis, of special melting and cast equipment such technological processes of creating the materials become economically expedient, and their usage in already existed methods of casting production e. g. in technique of producing steel and cast iron castings with termite