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ENCLOSURE FOR TESTING THE ELECTROMECHANICAL DEVICES WHEN CHANGING THE EXTERNAL CONDITIONS

BY

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Abstract. The use of electromechanical devices in many areas has led to the need to solve problems related to their proper functioning and the possibility that some external factors may affect their operation. The purpose of the developed research was to design and materialize a solution to test the operation of the computer hard disk as an electromechanical device. The systemic analysis method was used to highlight the factors capable of influencing the operation of a computer's hard disk. The components of a hard disk performance testing equipment were identified to evaluate the operation of the hard disk at the variation of some input factors. An enclosure solution was subsequently established and implemented using the idea diagram method to evaluate the functioning of the hard disk when changing the values of some input factors capable of affecting the intensity of the process of losing the functional qualities of the hard disk.

Keywords: electromechanical device; hard disk; influence factors; systemic analysis; research enclosure; ideas diagram method.

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1. Introduction

In principle, any device with an electrical and a mechanical component can be considered as *an electromechanical device*. Thus, even an electric motor can be viewed as an electromechanical device because it converts electricity into mechanical energy and includes both mechanical components and components in converting electricity.

A system can be called *electromechanical* if it has electronic and mechanical components.

Most current computers include electromechanical devices, such as hard disks. The ventilation systems are partially electromechanical, but there are currently computers that do not incorporate any moving parts.

The operation of mechanical components usually leads to a certain loss of the functional characteristics of the components of electromechanical devices or systems, either by changing some physical and mechanical properties of the component materials or by wear processes. As such, aspects related to the loss of functional properties of electromechanical devices have been the objectives of scientific research activities.

Thus, in 1981, Gunn proposed using a method for accelerated temperature and humidity testing, tracking the corrosion behavior of NMOS-type microelectronic circuits used for logic and memory chips (Gunn, 1981).

Leng and Teen have designed and implemented an expert system for repairing and maintaining personal computers (Leng and Teen, 1992). This expert system has proven to be a useful solution for shortening the duration of repair and maintenance activities.

Chase *et al*. designed and patented equipment for accelerated testing of devices at cyclic variations in temperature, humidity, and pressure (Chase *et al*., 1993).

In a doctoral thesis defended in 2013 at the University of Pisa, N. Constantino analyzed the possibilities of designing, making, and using devices for testing electronic devices in severe operating conditions (Constantino, 2013). The author contributed to the design and development of an intelligent power switch. It is possible to test overvoltages and overcurrent, the wrong connection of polarity, in the presence of parasitic effects and overtemperature phenomenon.

A study published in 2013 shows that electronic systems can incorporate components from organic materials, permeable to moisture, and this permeability can affect their proper functioning (Electronic, 2013). Experimental tests were performed, highlighting the influence of moisture concerns on high-speed signal propagation.

Espinet *et al*. proposed an algorithm that evaluates the operating status of a computer network by processing signals from measurement probes placed in the network (Espinet *et al*., 2016). In this way, a way of intervention can be

outlined to identify the severity of the degradation and establish measures to remedy the situation.

In a patent published in 2019, Gregor *et al*. presented a complex system and a method for testing material systems at cyclic thermal stresses.

The influence of temperature and humidity on some electronic power devices, such as microinverters and photovoltaic modules, was studied by Flicker *et al*. (2016). They found a good operation of the devices tested for long test times under normal conditions of use.

A broader definition and approach of a testing system must consider the system as a whole and allow the investigation of its many aspects (What, 2021).

In the present paper, the design and materialization of an enclosure to verify the hard disk in the structure of a computer were considered.

2. The Problem Addressed

As mentioned above, the problem of designing an enclosure that could be used to test the operation of a computer component, namely the hard disk, was formulated.

Use of systemic analysis in the enclosure case intended for testing the hard disk. Attention was first paid to identifying those factors that could influence the parameters that define the proper functioning of the hard disk. For this purpose, it was appreciated that the use *of systemic analysis* was possible. In principle, the method of systemic analysis transfers the characteristic of a system to the process or entity investigated.

It was appreciated that systemic analysis might be one of the methods of analysis used to reveal factors that may affect the values of the output parameters of the system under investigation. It could also clarify the correlations between the input factors and the output parameters of the process under consideration. In this case, as a process under analysis, we will consider the *degradation of the components of a computer system,* especially *the hard disk*.

As the main groups of input factors (independent variables) of the hard disk degradation process, the following could be considered:

a) Characteristics of the materials used in the composition of the investigated system (materials of the parts from which the hard disk is made, the ability of these materials to maintain their functional properties to the variation of environmental conditions, the reliability of the components, etc.);

b) *Quantities that characterize the environment in which the hard disk could operate* (temperature, humidity, the presence of air currents, vibrations, dust, the operating characteristics of the cooling subsystem, etc.);

c) *Parameters corresponding to the power supply conditions of the hard disk* (electrical voltage, frequency of voltage variation, etc.);

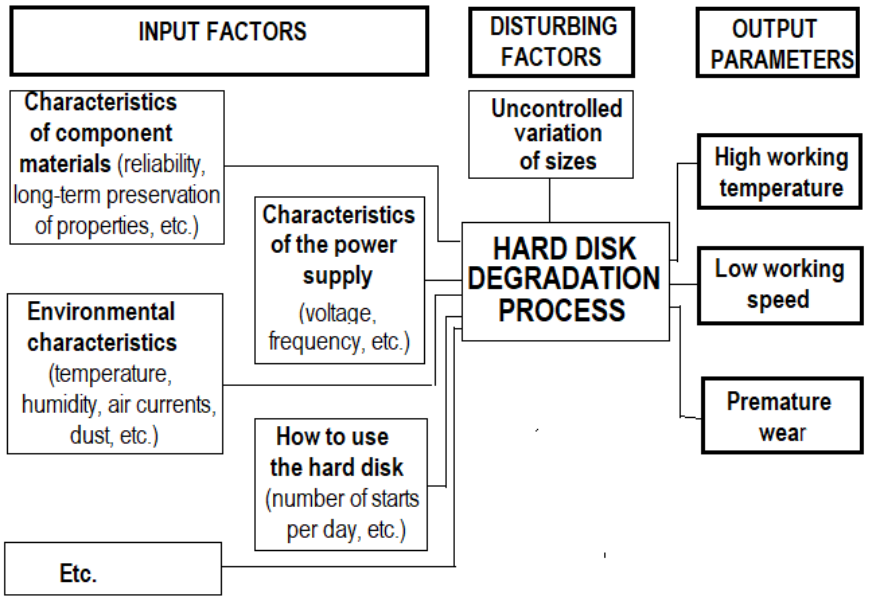

Fig. 1 – Schematic representation of the results of applying the systemic analysis method in the case of the degradation process of a computer's hard disk.

d) *Parameters that define the conditions of use of the hard disk* (daily number of commissionings of the computer, etc.);

Disturbing factors are those whose values cannot be adequately controlled and whose variation could affect the values of the output parameters of the investigated system. In the case of the hard disk, such factors could be:

– uncontrolled variation of the values of the electrical parameters corresponding to the power supply of the hard disk (voltage, frequency, etc.);

– uncontrolled variation of the values of some factors that define the environment in which the hard disk operates (variation of the ambient temperature, of the thickness of the dust layer deposited on the hard disk, of the stress level to which the computer system is subjected to a so-called nominal level of stress, etc.);

– incorrect maneuvers performed by the computer system operator;

– a high level of radiation existing in the room where the computer system is located;

– various combinations of the values of some of the factors mentioned above, with the possible summation of the negative effects of some factors, etc.

Figure 1 shows a graphical representation that considers some of the results of the systemic analysis performed.

Using the idea diagram method to finalize the solution of a hard disk performance test chamber. The use of systemic analysis allowed a subsequent identification of the main components of the enclosure intended to test the operation of the hard disk. Next, the ideas diagram method (Belous, 1990; Slătineanu, 2019) was used to highlight the different alternatives of the enclosure components.

It is known that *the ideas diagram* is a graphical representation in which, along with some vertical columns, the main subassemblies of the desired constructive solution are mentioned first, following that vertically, in each column, to include the different alternatives of the subassemblies or components taken into account. Both along the horizontal line containing the subassemblies of the solution and at the bottom of each of the columns corresponding to the materialization alternatives of each subassembly, some rectangles containing question marks were included. These question marks should highlight the fact that there may be other subassemblies and alternatives of subassemblies, respectively, which could be identified in the future.

Starting from the previous professional experience, we choose those alternatives of each subassembly that, together, could lead to an innovative solution. However, an improved selection of certain alternatives of the enclosure components can be based on an optimal method of selecting an alternative from several available alternatives.

We will find that when the number of subassemblies and the number of variants of the subassemblies are not small, a large number of combinations of all alternatives of subassemblies can be reached. The total number of N_{tc} combinations corresponds to the relation:

$$N_{tc}=n_A \cdot n_B \cdot n_C \cdot n_D \cdot \ldots \cdot n_N, \tag{1}$$

where n_A, n_B, n_C, n_D, ..., n_N are the alternative numbers of each subassemblies *A*, *B*, *C*, *D*, ..., *N*.

As subassemblies or main components of the hard disk drive enclosure, the following have been considered:

a) The enclosure itself;

b) The hard disk positioning subassembly in the enclosure;

c) The subassembly for measuring the temperature inside the enclosure;

d) The subassembly for measuring the humidity level inside the enclosure;

e) The subassembly for increasing the temperature inside the enclosure;

f) The subassembly for decreasing the temperature inside the enclosure;

g) The subassembly for connecting the hard disk to the computer and to the power supply.

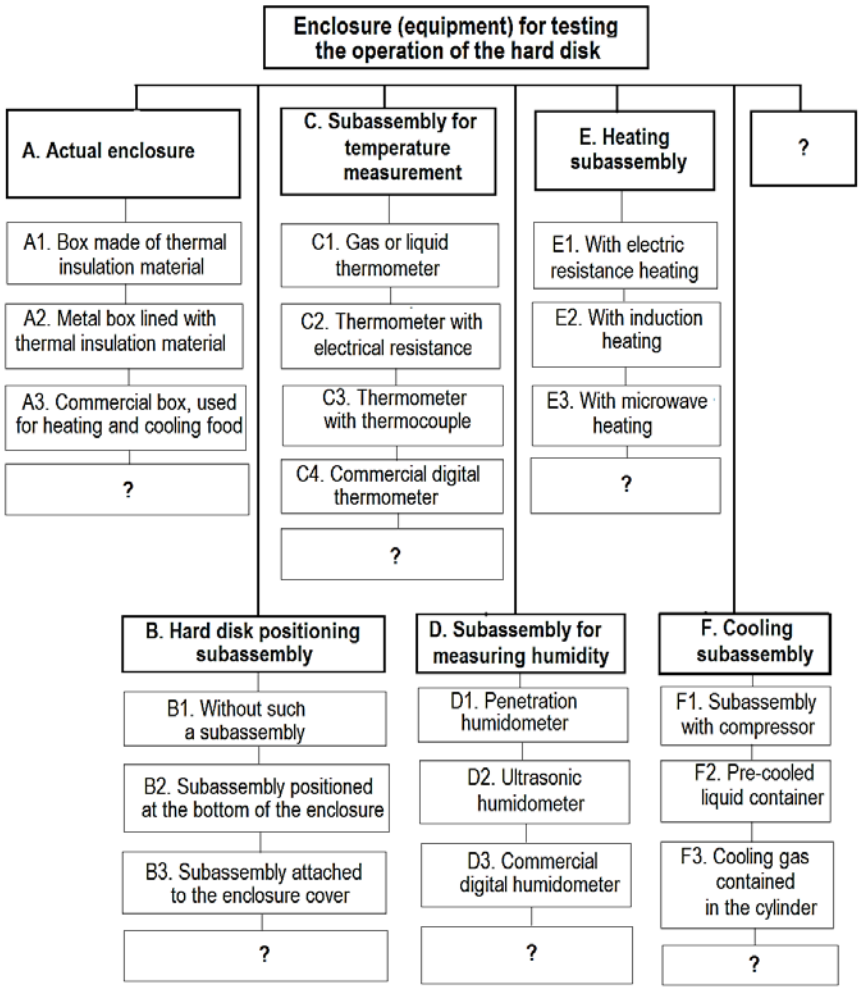

Fig. 2 – Diagram of ideas made to identify an enclosure for testing the operation of the hard disk.

Suitable alternatives have been identified for each subassembly, as mentioned earlier.

A graphical representation of the use of the idea diagram method in the case of the hard disk performance test enclosure can be seen in Fig. 2.

3. The Solution Achieved

Using an overall assessment method, it was appreciated that a combination of alternatives of the enclosure components that could meet the requirements for testing the hard disk could be the one designated by the symbols

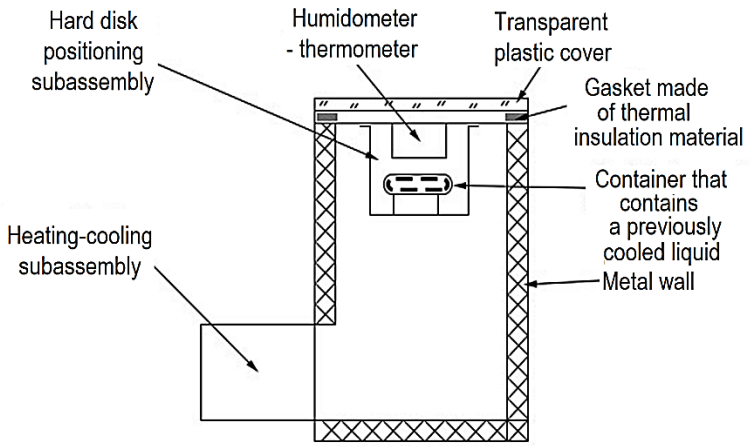

Fig. 3 – Side view of the enclosure made to test the operation of a computer's hard disk.

*A*3 (commercial freezer and food heating box) - *B*3 (hard disk positioning subassembly attached). at the enclosure lid) - *C*5 (digital thermometer) - *D*3 (commercial digital humidometer) - *E*1 (electric heating) - *F*2 (cooling with a container containing previously cooled liquid in a refrigerator). A more detailed analysis of what the combination in question entails highlighted that a device identified on the market allows the measurement of both temperature and humidity. It was also found that there are commercially available boxes/containers for heating and cooling food, and it was appreciated that such an enclosure could also be used for hard disk testing equipment.

4. The Solution Achieved

Starting from the alternative considered to be the most convenient and accessible for the enclosure intended for testing the hard disk operation, the components were purchased commercially or manufactured within the Department of Machine Manufacturing Technology, later moving to their assembly.

A view of the enclosure for testing the computer's hard disk operation can be seen in Fig. 4.

5. Conclusions

The need to design and materialize an enclosure for testing the operation of a computer's hard disk drive led to the use of systemic analysis to highlight factors that could contribute to hard disk degradation. A small number of such

factors were selected from these factors, the values of which could be changed during the experimental tests, to see to what extent their variation could affect the values of some parameters of normal computer operation. Subsequently, the subassemblies that could be used in an enclosure to test hard disks and alternatives of these subassemblies were identified, respectively. The use of the ideas diagram method led to a graphical representation of the subassemblies and alternatives of subassemblies considered. Through a global assessment, the enclosure alternative was established. This solution resulted from using alternatives of subassemblies that could be purchased commercially or practically made in the department. In the future, it is intended to perform experimental tests to test the operation of the hard disk by changing the values of some of the input factors in the operation of the hard disk, which could also contribute to affecting the normal operation of the hard disk.

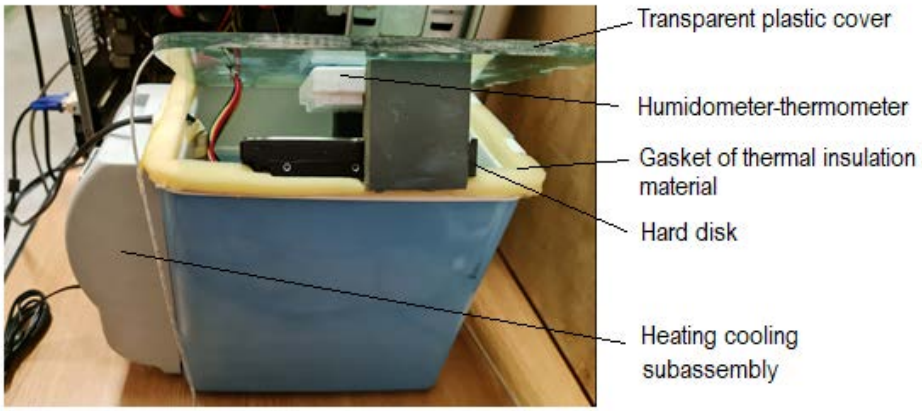

Fig. 4 – View of the enclosure for testing the computer's hard disk operation.

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INCINTĂ DE TESTARE A FUNCȚIONĂRII UNOR DISPOZITIVE ELECTROMECANICE LA VARIAȚIA CONDIȚIILOR EXTERIOARE

(Rezumat)

Utilizarea dispozitivelor electromecanice în multe domenii a condus la necesitatea rezolvării problemelor legate de buna funcționare a acestora și la posibilitatea ca unii factori externi să le afecteze funcționarea. Scopul cercetării desfășurate a fost acela de a proiecta și materializa o soluție de testare a funcționării discului dur al calculatorului considerat ca un dispozitiv electromecanic. Metoda analizei sistemice a fost folosită pentru a evidenția factorii capabili să influențeze funcționarea discului dur al calculatorului. Pentru a evalua funcționarea discului dur la variația unor factori de intrare, au fost identificate componentele unui echipament de testare a performanței discului dur. Folosind metoda diagramei de idei, a fost ulterior stabilită și implementată o soluție constructivă de incintă pentru a evalua funcționarea discului dur la modificarea valorilor unor factori de intrare capabili să afecteze intensitatea procesului de pierdere a calităților funcționale ale discului dur.