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E-LEARNING SYSTEM FOR USING THE MORPHOLOGICAL MATRIX METHOD IN THE TECHNICAL CREATION

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***Abstract**: In technical creation domain, there are a lot of methods and techniques that can be used for stimulation of technical creativity. These methods and techniques can be divided into two main categories: the psychological creativity methods and the logical (logical-combinatorial) creativity methods. These two types of methods are both used, but the key of success is the alternative use of them. The morphological matrix method consists on the logical combination of elements from a technical system. This way, it is possible to obtain new technical solutions, according to the combination generated. The morphological matrix can be linear, flat, spatial, according to the number of classes (forming assembly) in which can the elements of the technical system analyzed can be divided. This method is easy to use, when the number of forming assembly is small and the number of elements of each forming assembly is also small, too. When the morphological matrix is complicated, it is difficult to work with a great number of combinations. Then, it is necessary for an intelligent system. The proposed system will be used for automatic obtaining of the combinations of elements of a morphology. At first, the user establishes the type of the morphological matrix which he will use (flat-with two forming assembly; spatial-with three forming assembly; spatial-with 4 forming assembly etc.). After that, it is necessary to establish the number of elements for each forming assembly. Then, the elements of the forming assembly must be charged and, finally, the process for making the combinations can begin. The system shows all the mathematical–possible combinations. The user can divide this combinations in three sets: known combinations, impossible combinations and new combinations. The system can eliminate itself some impossible combinations, according to a list of incompatibilities between some elements of the forming assembly. The proposed system can be used for the students' training in the morphological matrix method, and in the same time can be used for a new creation theme, according to the new combinations generated by the system.*

***Keywords:** creativity, morphological matrix, combinatorics, creativity stimulation*

I. INTRODUCTION

Morphological matrices are some of the best means, tools, methods of structuring, organizing, grading, generating, combining, evaluating and selection of information used in science and technology. Morphological matrix method is constituted as a method of intellectual work, aimed at streamlining scientific research activities, scientific and technical, design, engineering, etc.

According to [2], [5], [6], [9] morphological matrix method (morphological method), as a method of creation, fall within the category of logical-combinatorial-deductive methods of inventics, along with: the generalized object method of technical creation, generalized method of logical synthesis of technical solution and general algorithm of solving inventive problem.

The widespread use of morphological matrices in creation, research, design, etc. is due to many advantages they present. First, morphological matrix method is an easy way to go for the detection of new, original combinations (solutions, options) especially when the number of elements that combine is reduced.

Also, morphological matrices are of the most generality, which comes from the high degree of abstraction of the information presented. Thus, in essence, a morphological matrix allows a series of combinations between codes, which designate certain data, information, ideas, images, elements, subassemblies, assemblies, etc. This character of generality allows usage of morphological matrices in very different areas of technical and beyond [3], [4].

Morphological matrix method as a method of intellectual work is located in compliance with the requirements of rigorous intellectual work, characterized by a tendency to examine totally, exhaustively the studied field [6], [7].

II. THE METHOD OF THE MORPHOLOGICAL MATRIX

Morphological research using matrices is linked, naturally, by notions of morphology and combinatorial. The term "morphology" is used primarily in biology and linguistics. In biology, morphology designates form and structure of macroscopic or microscopic level of bodies [15]. In linguistics, the morphology means that part of the grammatical structure consisting of all rules for the formation of words, their internal structure and their formal changes in their various purposes, part of grammar that deals with the study of these rules [13], [15].

Morphology is closely related to combinatorics, one of the most creative techniques used. After Alex Osborn, most new ideas occur by combining [6]. When the number of elements to be combined is reduced, combining is an intuitive creation technique. When the number of items is high, combining is object of study for combinatorial in mathematics and becomes a morphological research technique [2], [6].

Fritz Zwicky was the one who used the concept of matrix, not in mathematical sense, but as a means of graphic inclusion of all combinations that can arise between elements of a structure (of a morphology) [21], [6], [15], [19], [20].

According to [6], morphological matrix is a global representation, suggestive of the morphological product of several forming assemblies. Forming assemblies are the multitude of elements that combine, that can be objects of thought, attributes of creation object, solution for achieving a particular attribute, classified constructive-functional solutions in terms of a particular attribute, object components, etc. All forming assemblies are called general morphology or morphology. All combinations between the elements of the forming assemblies are called morphological products forming and its research is called morphological research [6].

In fig. 1 is presented the morphological matrix of clamping schemes workpieces in fixtures [8], [10], [11]. The forming assemblies witch composes the morphology:

- A – number of main forces acting on the workpiece: A1 – one force; A2 two forces; A3 – three forces; A4 – four forces; A5 – five forces uniformly distributed;
- B – number of workpieces which can be clamped: B1 – one piece; B2 – two pieces; B3 – more workpieces placed linear on one row; B4 – more workpieces placed liner on two rows; B5 – more workpieces placed circularly;
- C – direction and orientation: C1 – forces parallel to each other, with same orientation, C2 – forces parallel to each other with opposed orientation, C3 – concurrent forces with convergent orientation, C4 – concurrent forces with divergent orientation.

Methodology for structuring and using of morphological matrix contain the following steps [15]:

- E1: listing and coding the forming assemblies (basic components of the product, the basic attributes of the product, which represent in the same time classification criteria for the solutions for each attribute, function, criteria, etc.);
- E2: establishing simplified graphics for each element of the forming assemblies;
- E3: tracing of the morphological matrix. In case, there are more than two forming assemblies, then the space matrix/ matrices generated can be «broke down », in order to obtain a flat matrix for viewing all possible combinations;
- E4: eliminating the known solutions and the divergent-incompatible ones;

- E5: establishing a decision method for the hierarchy of new solutions;
- E6: enforcing a decision method and determining the optimum solution.

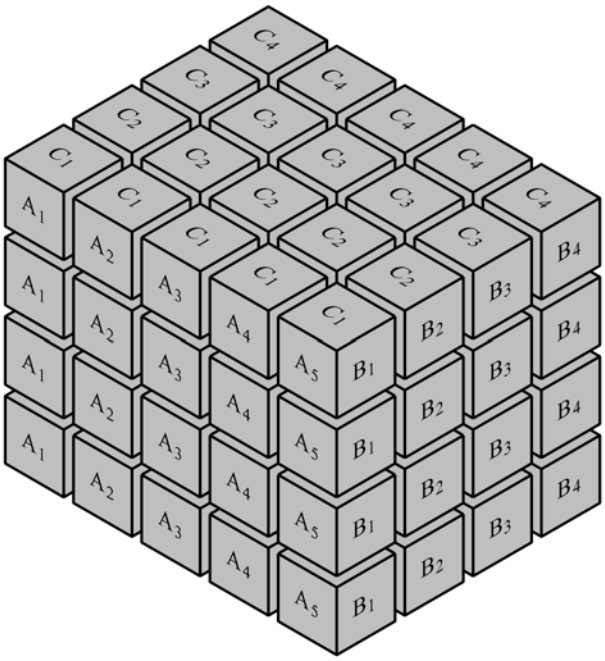

Figure 1. Morphological matrix of workpiece clamping schemes in fixtures

Depending of the different practical situations the methodology can be customized by adding new step or by removing the existing ones.

III. THE PROPOSED E-LEARNING SYSTEM

The e-learning system proposed in this paper is performed in Microsoft Access programming environment. The system allows the uploading of a number of four forming assemblies. Experienced has shown that there are rare the cases when there can be structured more than four forming assemblies [12], [14]. The system can structured to include a larger number of forming assemblies if the situation requires. In each forming assembly can be loaded components. The number of forming elements is unlimited. This can be introduced in encrypted form or in explicit form. There are situation when the elements can be introduces clearly indicating the names, or abbreviated. It also should be considered that when is necessary the elements of the forming assemblies can be represented by images. The decision on the form representation is depending on the nature of the forming elements and depending on the skill level of system users.

The system shows it's in usefulness in large number of forming assemblies and elements. Has been found that it is difficult to manage all possible combinations when their number is large [1], [16], [17], [18].

The use of system is illustrated in Fig. 2, trough a simple application. Is presented the main window of the system, where under codified form the component elements of the three forming assemblies that compose the morphological matrix, from fig. 1 are loaded.

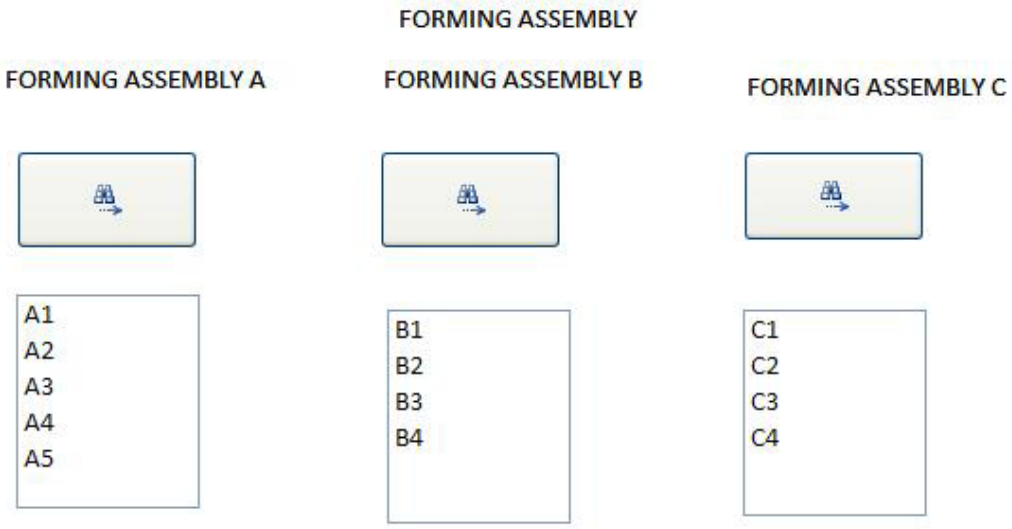

Figure 2. The main window of the system

The system allows viewing of all mathematical possible combinations and shows also their number (fig. 3). In the example considered, there are four forming assemblies A, B and C. The elements of the forming assemblies are: A1, A2, A3, A4, A5; B1, B2, B3, B4; C1, C2, C3, C4. The numbers of the mathematically-possible combinations are 5x4x4=80.

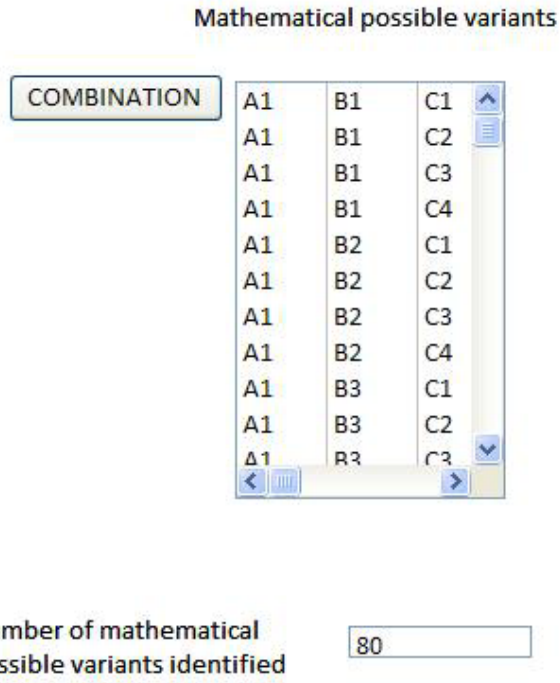

Figure 3. Viewing of the number of combinations and their number

There are situations that may require some incompatibilities between certain elements of the forming assemblies. In the case of the clamping elements it can be applied the principle of incompatibility of motion transmission [10], [14], [15]. Thus, we can remove all the combinations that contain the pairs of incompatible elements.

For the example shown in Fig. 1, incompatibilities are presented in Fig. 4.

Figure 4. The window for recording the pairs of incompatible forming elements assemblies

Further, the system displays all possible combinations of technical and removes all divergent-incompatible combinations [14]. It also displays the number of technically-possible combinations (fig. 5).

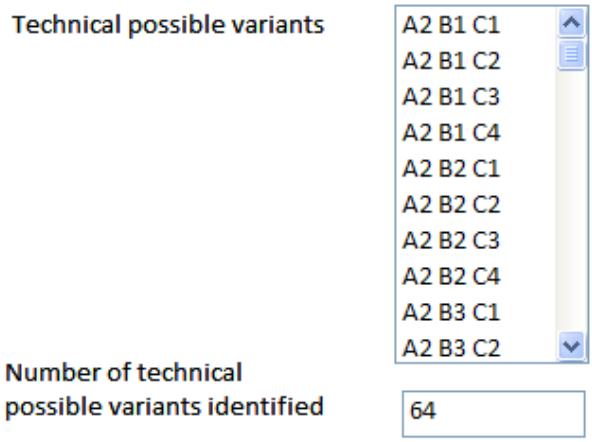

Figure 5. The display of the technical possible combinations and their number

IV. CONCLUSIONS

The system presented in this paper can be used in order to apply more convenient and efficiently the method of morphological matrices. The system is very useful when the morphology analyzed is complex with a large number of forming assemblies and large number of elements. In such situations it is difficult to visualize all the combination between the elements of the forming assemblies.

Also the proposed system can be used in order to stimulate the technical creativity of the pupils and students for acquiring the morphological method. For this, it can be applied the matrix method for simple morphologies, as presented in this paper.

One of the main advantages of this method is the possibility of automated elimination of the incompatible combinations. In this way, the users attention is focused exclusively on the technical viable combinations.

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