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MORPHOLOGICAL MATRICES APPLICATION IN CASE OF LOCATION-POSITIONING DEVICES WITH TILTABLE PLATE

BY

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Abstract. The analysis of the methods and devices of measuring and verifying the angular dimensions leads to the conclusion that technologies have been developed and can be further developed for the control of angles between flat surfaces, for the application of which existing control equipment can be used, as well as other types, solutions, variants of technological devices for controlling angular dimensions. This diversity is mainly due to the diversity of the parameters and parts to be controlled and the diversity of the technical systems in which the technological devices are integrated, respectively, their constructive and functional parameters. Morphological matrices are one of the most effective tools for structuring, systematizing, combining, and evaluating existing solutions in this specific field and, it aims to make the research activity more efficient, thanks to its creative potential. The present paper considers the solutions for location-positioning with tilting devices using morphological box and presents the main principial solutions to develop the proper constructive solution in this specific field. Both the spatial and the flat morphological matrix are taken into consideration.

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Keywords: device with tiltable plate, morphological matrices, angular dimension.

1. Introduction

Morphological research through matrices is related to morphology and combinatorial. Combinatorics is one of the most used creative techniques, through the application of which, according to Alex Osborn, most new ideas appear (Seghedin, 2008).

Also, the morphological matrices have a character of maximum generality, which comes from the high degree of abstraction of the information presented. Thus, in essence, a morphological matrix allows the realization of some combinations between some codes, which designate certain data, information, ideas, images, elements, subassemblies, assemblies, etc. (Belous, 2005; Plahteanu, 1999).

Morphological matrices encourage the exploration of unconventional combinations, making possible a multidimensional analysis of a system, considering various parameters simultaneously, but, on the other hand, they have some limitations because the number of possible combinations can grow exponentially, making it challenging to explore all possible solutions. This character of generality means that the morphological matrices can be used in very diverse technical fields and not only that (Knolmayer and Borean, 2010).

Zwicky was the one who used the notion of the matrix, not in a mathematical sense, but as a means of graphically including all the combinations that can appear between the elements of a structure (of a morphology) (Seghedin, 2008). He called the morphological matrix a "morphological box".

A morphological research methodology can be followed that contains the following stages:

I: enumerating and coding the elements of the forming assemblies (the basic components of the product; the basic attributes of the product, which represent, at the same time, classification criteria; the solutions for each attribute, function, criterion, etc.);

II: establishing simplified graphic representations for each element of the forming assemblies;

III: drawing the morphological matrix. If there are more than two forming ensembles, then the generated spatial matrix/matrices can be "unfolded", so as to obtain a flat matrix, for the visualization of all possible combinations;

IV: elimination of known solutions and divergent-incompatible ones;

V: establishing a decision method for ranking new solutions;

VI: applying a decision method and establishing the optimal solution (Seghedin, 2008; Ritchey, 2017).

2. Consideration for the constructive solutions

The location-positioning device with a tilting plate must satisfy several requirements:

• to ensure the adjustment of the tilting angle of the tilting plate, within limits established by the initial data, adjustment of the tilt angle will be made in two steps:

• a coarse adjustment step, in a range of approx. ±3 degrees;

• a fine adjustment step, in a range of approx. ±6 minutes;

• ensure the measurement of the angle of inclination of the tiltable plate with a reading accuracy of at least 6 minutes;

• to ensure the maintenance at the materialized value of the inclination angle by integrating a tilting plate locking element;

• can be positioned on the active surface of the base plate for different types of measurements;

• to include elements for location-positioning of parts and with other types of surfaces than flat ones.

Due to the multitude of types and dimensions of machine parts and cases of geometric elements with angular dimensional characteristics, several verification and measurement methods are applied to the control of angles, divided into three distinct categories (Fig. 1.1):

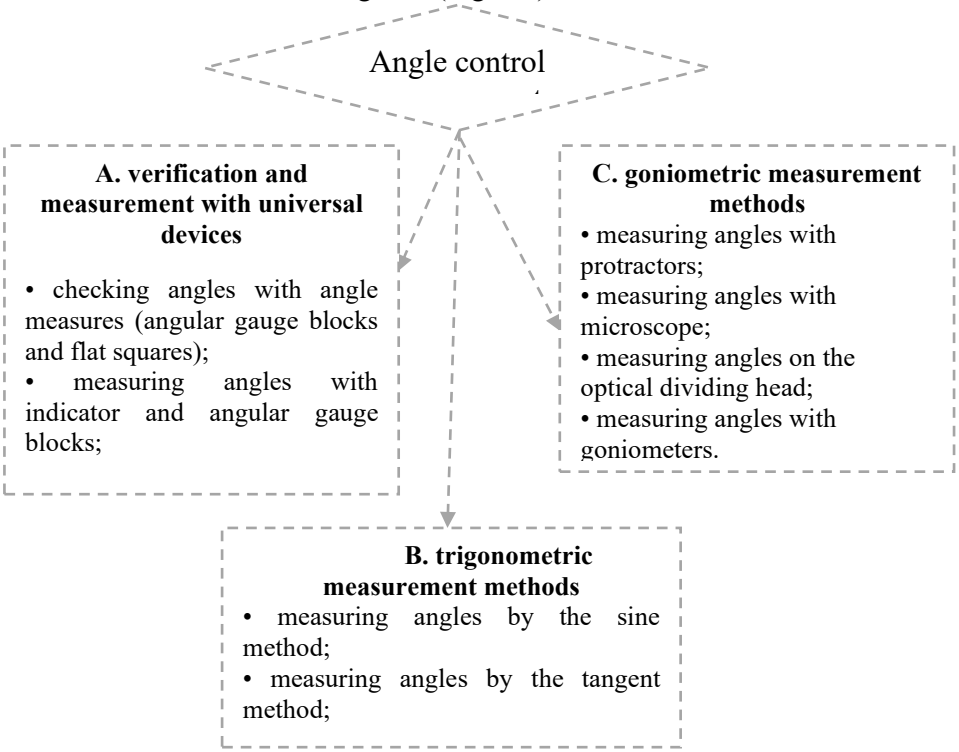


Fig. 1.1 – Angle measurement categories.

Several methods of checking and measuring are applied to control angles, but the tiling plate is usually used for the location and positioning of the various parts.

Tilting plate devices are devices used for placing parallelepiped parts with inclined surfaces, with the function of orienting the inclined surface of the part, horizontally, in the direction of movement of the probe. To fulfil its function of orienting the inclined surface in the horizontal plane, a device has, as its main element, a support plate of the part to be controlled and which inclines with angles whose value is measured with protractor-type instruments.

The general structure of a tilting plate device includes the following elements (Fig. 1.2):

- actuation and transmission elements;
- tiltable support plate;
- element for tilting the support plate;
- support plate locking element;
- the instrument for measuring the angle of inclination

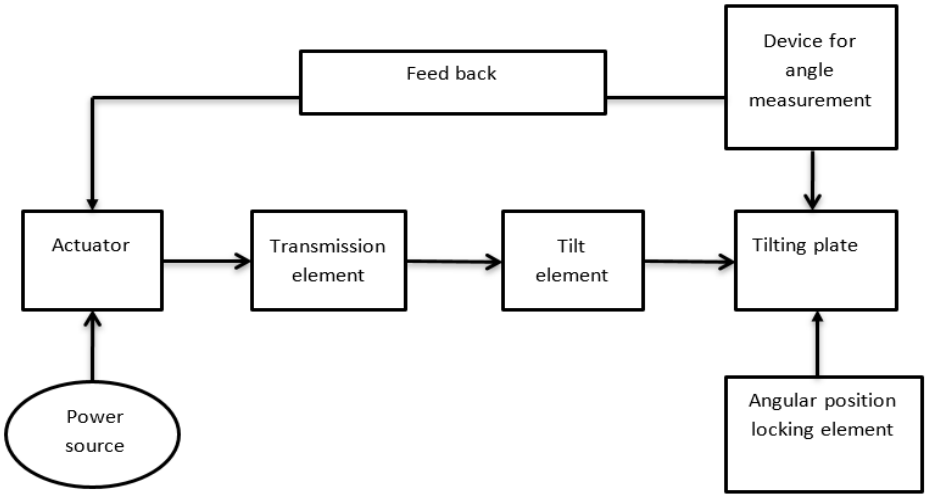


Fig.1.2 – General structure of a tilting plate device.

Depending on the elements' characteristics in the tilting plate device's general structure, a series of criteria for classifying tilting plate devices have been identified. Based on these criteria, the morphological matrix was realized.

3. Morphological matrix

The morphological matrix is a global, suggestive representation of the morphological product from several forming ensembles. Formative ensembles

are the sets of elements that combine, which can be: objects of thought, attributes of the object of creation, solutions for achieving a certain attribute, constructive-functional solutions classified from the point of view of a single attribute, the components of the object, etc. The totality of combinations between the elements of the forming ensembles is called a morphological product, and its research is called morphological research (Slatineanu, 2019).

In the considered case, the morphological matrix is obtained from the combination of three forming ensembles:

1) A - The tilting mechanism: *A1*- mechanism with oscillating slide; *A2* - cam mechanism; *A3*- rack and pinion gear; *A4*- mechanism with levers; A5- screw-nut mechanism; *A6*- inclined plane mechanism; *A7*- connecting rod-crank mechanism; A8 - piston-cylinder mechanism; *A9*- mechanism with cables.

2) B - Actuation mechanism: *B1* - Screw-nut mechanism; *B2* - Step hydraulic mechanism; *B3* - Manual; *B4*- Gear;

3) C - The number of directions it leans: *C1*- in one direction; *C2* - in two perpendicular directions.

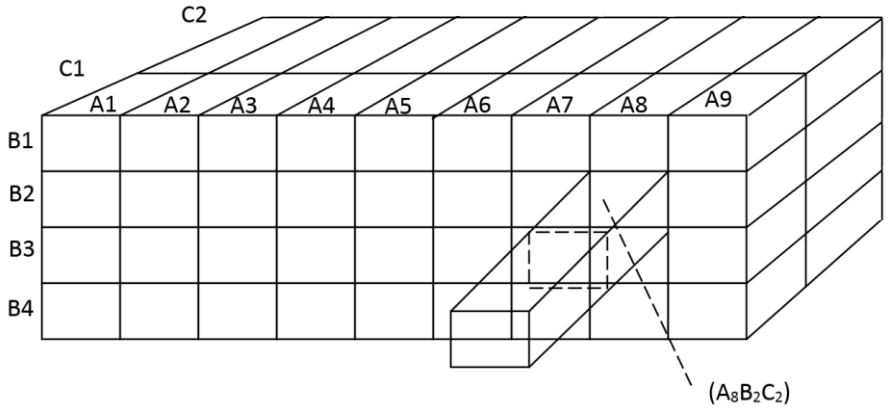


Fig. 1.3 – The spatial morphological matrix of the tilting plate device.

Thus, one can develop the solution $A_8B_2C_2$ (tiling plate with piston-cylinder mechanism for the plate inclination, with the step hydraulic mechanism for the positioning in two perpendicular directions) and obtain the new product.

We can develop this "morphological box" by adding new criteria as D - How to adjust the tilt angle: *D1*- Continuous adjustment; *D2*- Adjustment in steps; E - The number of adjustment steps: *E1* - A single adjustment step; *E2* - Two adjustment steps; F - Accessories for fixing the part to be controlled: *F1*- without accessories; *F2* - With vise; *F3* - With flanges; *F4* - With prisms; *F5* - With centering tips. Thus, the number of possible combinations can grow

exponentially, making it difficult to find all possible solutions and to choose the optimum one.

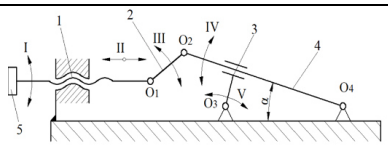
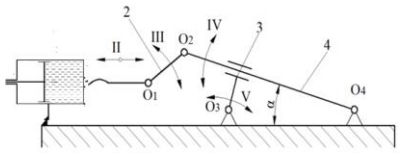
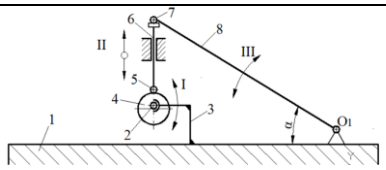
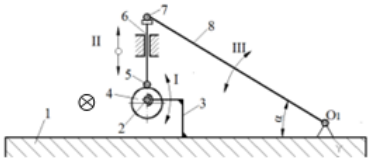
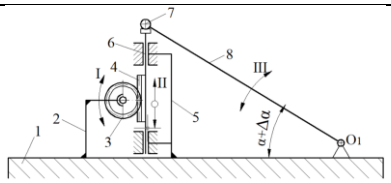
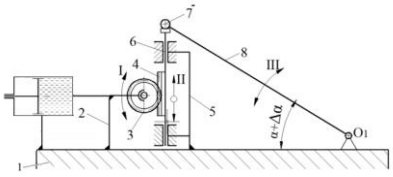
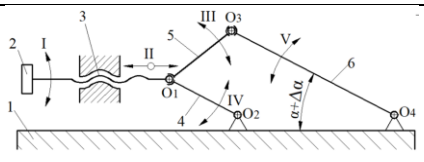
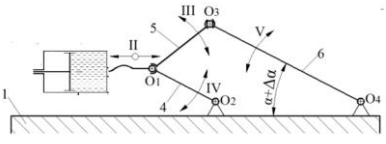
According to the specialized literature in the field in mechanical engineering, it turned out that many scientists used morphological matrices, where the combinations of the component elements were presented not only in the form of codes (as boxes), but also in the form of images. These types of morphological matrix are more intuitive and offer an exhaustive image (Table 1).

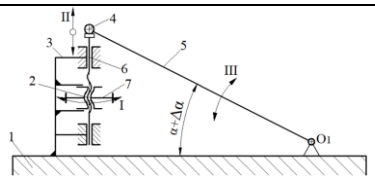
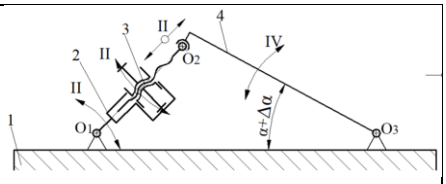
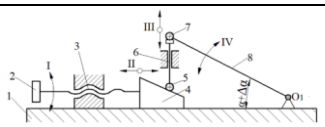
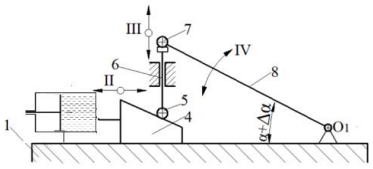
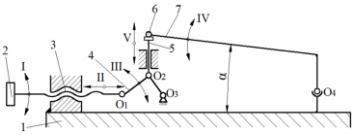
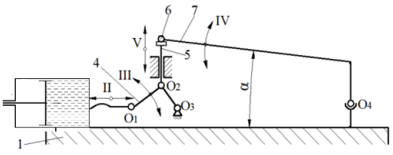
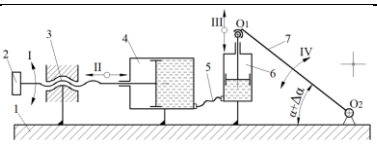
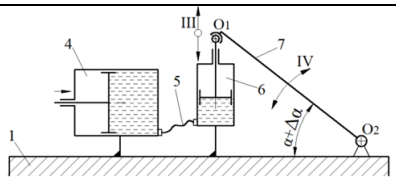
1) A - The tilting mechanism *A1*- Mechanism with oscillating slide *A2* - Cam mechanism, *A3*- Rack and pinion gear *A4*: Mechanism with levers; A5 Screw-nut mechanism; *A6* - Inclined plane mechanism; *A7* - Connecting rod-crank mechanism; *A8* - Piston-cylinder mechanism; *A9* - Mechanism with cables

2) B- Actuation mechanism *B1* - Screw-nut mechanism, *B2*- Step hydraulic mechanism

Table 1

Flat morphological matrix of the tilting plate device

	B1	B2
A1		
A2		
A3		
A4		

A5		
A6		
A7		
A8		

The analysis of these solutions leads to the conclusion that for the control of angles between flat surfaces can be done with the existing control equipment as well with other types, solutions, variants of technological devices. This diversity is mainly due to the diversity of the parameters and parts to be controlled, as well as the diversity of the technical systems in which the technological devices are integrated, respectively, their constructive and functional parameters.

4. Conclusions

Morphological matrices have applications in various fields such as engineering and design, problem-solving, decision-making, and product development. In engineering, this technique generates innovative solutions. It helps determine the optimal configuration of components, features, and functionalities in product development, as in our case, to find the constructive solution for orientating and positioning the measured part using a tilting plate.

This paper shows that are many solutions for location-positioning with tilting devices, therefore, we developed a Morphological Box that

systematically presents the main features needed for handling these solutions and their characteristics.

Flat matrices are perhaps more intuitive than spatial morphological matrices but limited from the point of view of including as many possible variants as constructive solutions. The present paper presents the main principial solutions to develop the proper constructive solution.

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APLICAREA MATRICELOR MORFOLOGICE ÎN CAZUL DISPOZITIVELOR DE ORIENTARE-POZIȚIONARE CU PLACĂ ÎNCLINABILĂ

(Rezumat)

Analiza metodelor și dispozitivelor de măsurare și verificare a dimensiunilor unghiulare conduce la concluzia că au fost dezvoltate și pot fi dezvoltate în continuare tehnologii pentru controlul unghiurilor dintre suprafețe plane, pentru aplicarea cărora se pot utiliza echipamente de control existente, precum și alte tipuri, soluții, variante de dispozitive tehnologice pentru controlul dimensiunilor unghiulare. Această diversitate se datorează în principal diversității parametrilor și pieselor de controlat, precum și diversității sistemelor tehnice în care sunt integrate dispozitivele tehnologice, respectiv parametrii constructivi și funcționali ai acestora. Matricele morfologice sunt unul dintre cele mai eficiente instrumente de structurare, sistematizare, combinare și evaluare a soluțiilor existente și își propune să eficientizeze activitatea de cercetare în domeniul acestor dispozitive de control, datorită potențialului creativ pe care îl prezintă.