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3D CAD models library of flexible clamping system

Biblioteka 3D CAD modeli elementów uniwersalnych przyrządów składanych

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Described are the aspects of preparing and using 3D CAD models library dedicated to the CAD system by the example of flexible clamping system.

KEYWORDS: CAD, CAD models library, flexible clamping system

One of the basic conditions for giving the object the right shape during machining is its fixing in a specific position. To this end, instruments and machining holders are used [3]:

- normal handles (commercial) – produced by specialized plants and intended for fixing and fixing objects of relatively simple shapes (including: two-, three- and four-rake self-centering handles, machine vices, turning latches); these are usually universal holders, designed not for machining a specific part, but for a group of technologically similar parts;
- specialized handles – normal handles with additional equipment;
- special handles – handles used in series and mass production, when the object being processed has a shape that makes it difficult to fix and fix it properly, or when the time of starting the manufacturing process is important; they are made of standardized elements and designed from scratch;
- folding handles.

Universal folding devices (UFD)

Universal folding devices replace special handles, design and execution of which is very labor-intensive. The handles are assembled from a set of several dozen universal parts used for fixing, fixing the workpiece, but also guiding the tools. UFD components are sold in sets containing parts needed to assemble the designed holder. Handles are available in which a grid with spaced openings is used, with T-slots arranged in a crosswise manner or in a mixed system. Fig. 1 shows exemplary folding handles.



Fig. 1. Examples of UFD brackets

The main advantages of universal folding instruments are [3]:

- short assembly time of the handle,
- possibility of using a set of universal folding instruments to assemble various handles,
- using the folding handle to perform the test in order to perform a complicated special handle,
- no need to have special handle magazines for unit or small lot production.

A characteristic feature of folding handles is that the handle can be assembled on the basis of a hand-drawn sketch, a construction drawing of the object with already marked machining bases and machined surfaces or on the basis of the delivered item with machined treatment bases [3].

In the case of more complicated handles or the use of a set of UFD elements for the purpose of designing special holders, the use of CAx techniques becomes indispensable.

Computer-aided design of UFD-based machining holders

UFD manufacturers provide digital libraries of their products in file formats that can be opened in virtually any CAD system. CAD systems have specific functionalities, developed from version to version, enabling automation of design work, which, however, can only be applied to previously prepared files. The preparation process of the dedicated 3D CAD digital library has been presented on the example of a grooved system UFD set in the SOLIDWORKS software.

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In the first step, parametrical models of all components of the UFD set should be developed on the basis of technical documentation in such a way that all variants of individual types of parts are included in one file. In this respect, SOLIDWORKS enables the generation of variants based on the configuration table and the functionality of the "equation", thanks to which the model can integrate knowledge by applying logical and mathematical relations between features.

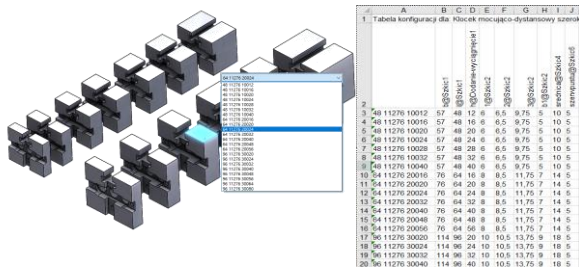


Fig. 2. Model in configuration

The files and the configurations defined in them should be written with the name uniquely identifying them and placed in the folders of a properly prepared library structure reflecting their functions in the holder. A typical UFD set consists of elements belonging to: bases, fixing elements, fasteners, fasteners and others.

The base elements play a fundamental role in the UFD device assembly. Above all, they form the foundation, bind the side walls, the guide elements of the tools, the workpiece clamping elements or other UFD components to the rigid whole. The size of the work surface of the base plate determines the size of the workpiece. With the help of the base, the UFD device is set and fixed on the table of the machine. The group of foundations include straight-angled, round and angle plates [8].



Fig. 3. Examples of UFD basic components

The retaining elements are a group of parts used to fix both the workpiece and other instruments. They are structurally different from the basics of their execution – their surfaces are machined with greater accuracy, and more dimensional versions are available. Fig. 4 presents exemplary setting elements. This group distinguishes among others: dowels, adjustable dowels, fixed stands, roller spigots, angles, prisms, support plates, elements with sloping surfaces.

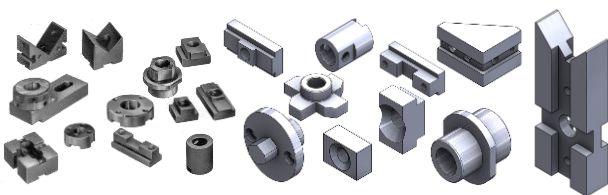


Fig. 4. Example of UFD retaining components

The task of the fastening elements is to ensure the non-variability of the position of the workpiece, defined by the retaining and retaining elements. The fastening elements transfer the clamping forces to the object, providing the required rigidity of the instrument-work-tool [8]. Several

types of fixing elements can be distinguished, e.g. clamping feet, rotating clamping feet, lever fixing assemblies or clamping sleeve assemblies.

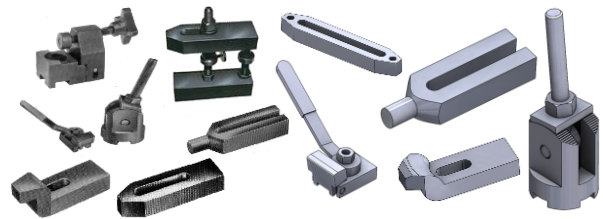


Fig. 5. Examples of UFD mounting elements

In addition, a wide range of bolts, washers and nuts should be distinguished. Bolts smaller than those with M12 thread should not be used due to the high load forces of the workpiece clamps. Bolts with M12 and M16 threads are most commonly used. There are also studs, hook, eye, socket and screws with a handle.

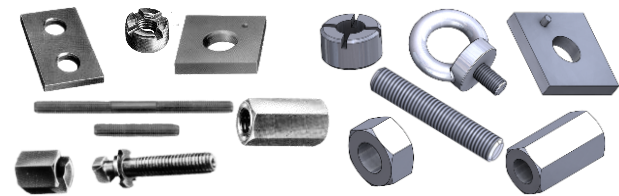


Fig. 6. Example of UFD fasteners

Models of the listed library elements should be provided with additional information – e.g. material, mass, description, name, standard – stored in properties adapted or specific to the configuration. These are collected during the generation of the statement of used UFD elements from the virtually assembled bracket.

In addition, while building a library, you need to use the potential of the software itself – here SOLIDWORKS – which will assist the constructor in automating repetitive tasks. The discussed software allows building "intelligent components". Due to this functionality it is possible to add to the model the assembly of the "smart component" handle along with the previously associated models and operations modifying the geometry of the solids in the project's models. After dragging such a file to the 3D area, the software automatically selects its configuration by adjusting the control dimension, taken from the model geometry element, on which the constructor will stop the mouse cursor. In addition, the "intelligent component" can be equipped with the so-called referencing the constraints that will allow the addition of constraints in the target assembly model in a similar way as in the case of configuration selection, i.e. by retaining the mouse cursor on the element to which the association is to take place.

When designing the handles, it is essential to analyze errors affecting the accuracy of the dimensions and position of the workpieces. The determination error – which results from the inaccuracy of the execution and the operation of the elements affecting the position and dimensions of the surfaces being machined – can be analyzed in the TolAnalyst integrated with SOLIDWORKS. This functionality requires the introduction of an annotation of geometric dimensioning and tolerance to 3D CAD models through the dedicated DimXpert tool. The UFD component library models should therefore be explicitly and explicitly described in the GD&T system.

The library of universal instruments prepared in this way are to improve the work of the bracket constructors, which has been tested on the examples – designed UFD holders for designated operations in the technological process of machining (fig. 8).

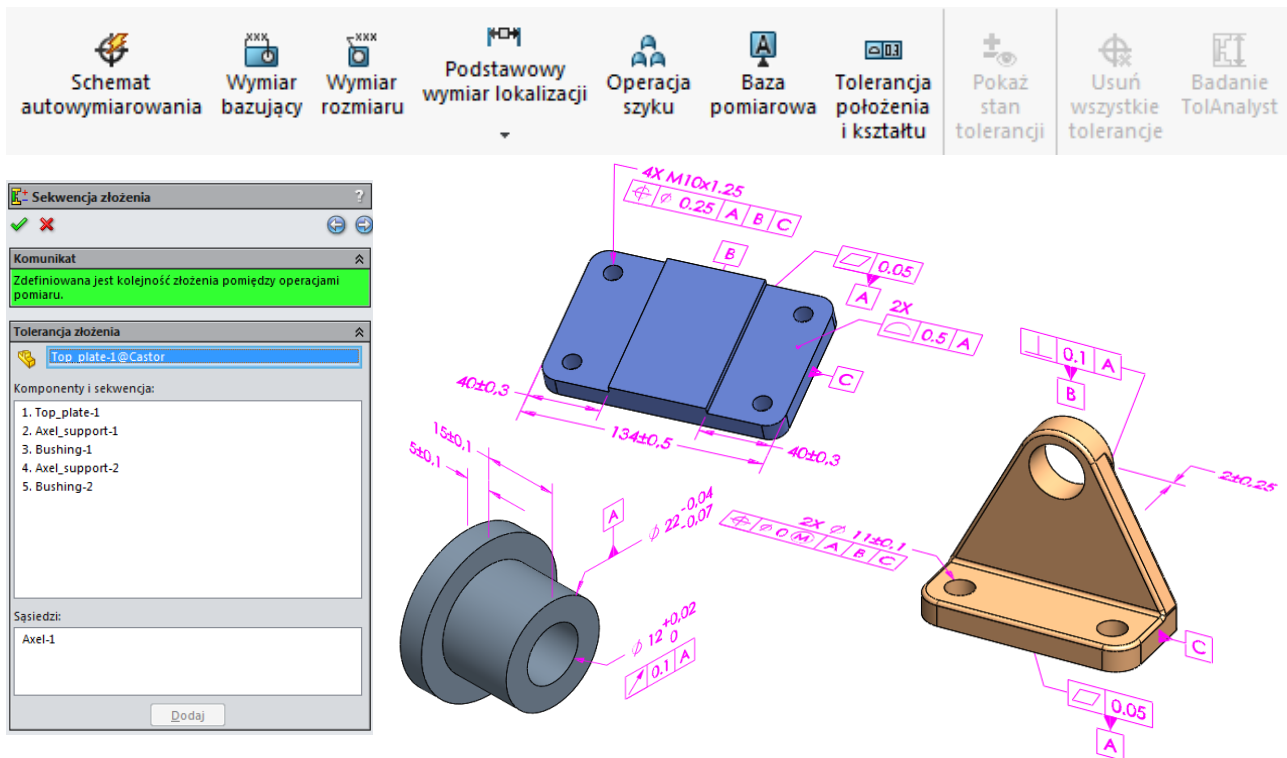


Fig. 7. DimXpert and TolAnalyst tools [9]

In the 3D CAD SOLIDWORKS environment, the basic design stage was carried out – an analysis of the subject matter. The main databases of the subject were determined, the subject placed in the reference system, and then free movements were removed by contacting the main bases with support elements selected from the library. In the next step, subsequent free steps were received by contacting the auxiliary bases with further models of the support member assemblies.

Finally, the directions of action of the components of the fastening forces were determined, the models of fastening assemblies were selected from the library and the fixing errors were analyzed. The technical documentation, statements and installation instructions were also generated.

Summing up, libraries designed for a specific CAD system offer the constructor greater flexibility and significantly accelerate the design of, for example, machining holders, compared to the use and implementation of models from producer libraries.

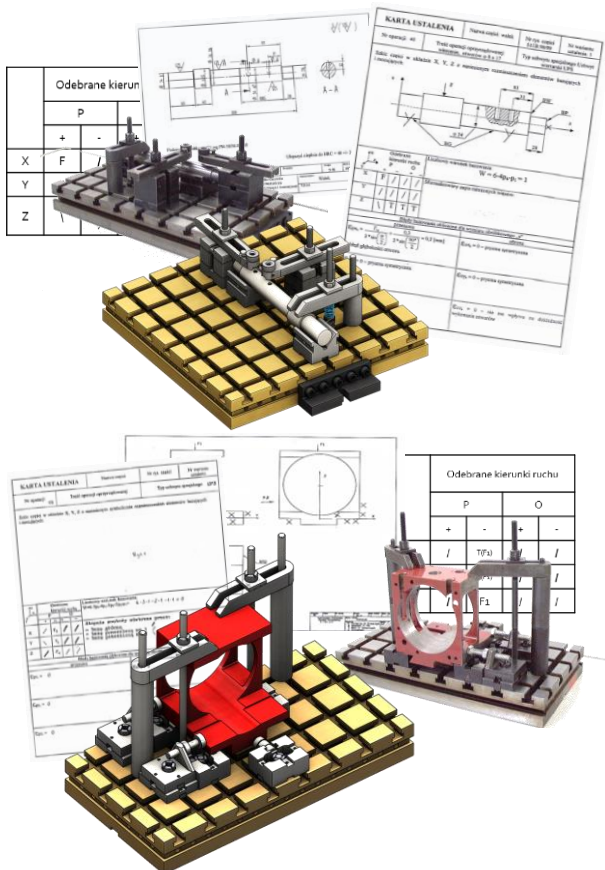


Fig. 8. UFD processing handles

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