USING NON-GRAPHICAL PROGRAMS
FOR TEACHING MATHEMATICS
(SPECIALIZED FOR GEOMETRY)

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Abstract. The paper deals with the possibilities of drawing the figures with program Microsoft Office Word 2003. Some advantages and disadvantages of using graphical and non-graphical programs for educational goals are mentioned. The built-in automatic shapes in program MS Office Word 2003 are described and all presented figures of geometric objects are created in it.

1. Introduction

There are many ways and possibilities for drawing pictures and figures today. Some specialized graphical programs allow drawing anything what user needs and wants. But it is often very difficult to master their tools and they are not accessible to everyone.

On the other side, there are non-graphical programs, which are accessible for most of users. They have often graphical environment with tools and shapes, which allow drawing figures suitable for teachers not only of mathematics but also of descriptive geometry. From the variety of programs for teachers, Microsoft Office Word has been chosen.

2. Drawing with program Microsoft Office Word 2003

At the beginning it is necessary to mention, that the program Word was not designed for precise graphic work, but many of its tools allow to draw quite accurate and complicated figures too. In Word, one can draw only with help of built-in automatic shapes and with using graphical tools. The advantage of such created figures is the step by step construction, which is for many users

very intuitive and resembles using classic drawing instruments – ruler and pair of compasses.

Another advantage becomes apparent by changing the figure size – the thickness of lines remains unchanged. This does not happen with regular figures inserted into the document from other graphical programs. This advantage has sense for user, who wants to print the document. Another one is that these created figures can be easily used also in presentation where the construction is presented step by step.

Some disadvantages of using Word to create figures are: time-consu-ming work, precision complications (offered 500% zoom is not sufficient), division of simple constructions into more details (point in exact distance, midpoint, circle with exact radius and midpoint ...) and other.

Of course, combination of graphical programs and Word can be also used. The figure can be drawn at first in graphical program and then redrawn in Word. Sometimes the conversion of the figures from graphical programs to Word can be used for creating figures too, if there is such possibility (some graphical programs don't support this way).

3. Drawing tools in MS Word 2003

All the tools for creating figures can be found in tool bar *Drawing* (Fig. 1).

Fig. 5: Tool bar *Drawing*

There are submenus *Draw* with graphic tools (Fig. 2), *automatic shapes* (Fig. 3), *other objects* (text box, WordArt, diagram or organization chart, Clip Art, picture) and also their characteristics (fill color, line color, text color, thickness of line, type of line, shape and size of arrows, shadow and space effects of object).

In the submenu *Draw*, there are functions for grouping, ungrouping or re-grouping of objects, setting the order of objects, setting the grid, aligning and distributing of objects, rotating and flipping of objects, setting the wrapping of text and other.

In the submenu *Automatic shapes*, there are functions for drawing many types of lines, connectors, basic shapes, arrows, diagrams, stars, callouts and possibility of choosing other automatic shapes too.

The *Shortcut menu* is often used for drawing automatic shapes. It can be displayed after right clicking on the object, or on the set of objects. After

clicking on the item *Format AutoShape* (Fig. 4) other properties of objects can be set up. For example it is their size, layout and so on.
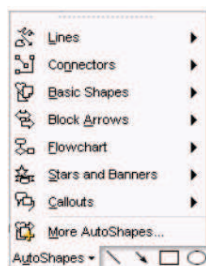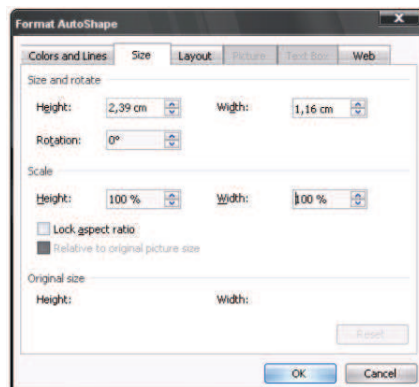

Figure 3   Figure 4

4. Examples and sequences of drawing figures

First of all, some recommendations:

- If the precision is important, it is good to draw figures with lines with thinnest thickness (0,25 pt, or it can be chosen also thickness 0 pt which is printable) with maximal zoom 500% (zoom can be modified with mouse wheel with key Ctrl).
- Closed objects and shapes are drawn without fill.
- If some parts of construction are repeated, then it is useful to change colors of objects.
- For creating new objects with the same setting the tool *Set AutoShape Defaults* can be used.

For creating and modifying objects the keys "*Shift*", "*Ctrl*"and "*Alt*"are used very often. They make the work easier. The demonstration of using these keys follows. For visualization of the changes, the original object (shape) is drawn with continuous line and the new one, which will be created by pulling at the handle of object with use of the mentioned keys, is drawn with dashed line:
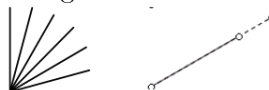
KeyŚhift":

This key can be used for preserve proportion. Some concrete examples:

- Drawing square, circle and regular figures (equilateral triangle, regular pentagon, hexagon, octagon ...).

- The new line is drawing with multiples of 15° angle and already drawn line is lengthening without change of direction.

- Objects are rotating with multiples of 15° angle around the midpoint.
- With the change of objects sizes the proportion is keeping.
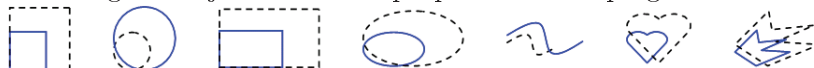
- Objects are moving only in vertical or horizontal direction.
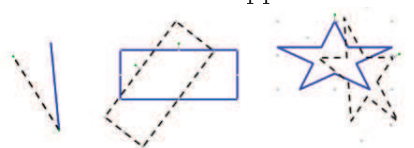- More objects can be marked at once.

KeyĆtrl":

Most frequently this key is used for copying objects, but there are other possibilities for using it. Some examples:

- New objects are created from the midpoints.
- Already drawn objects are changing from the midpoints.
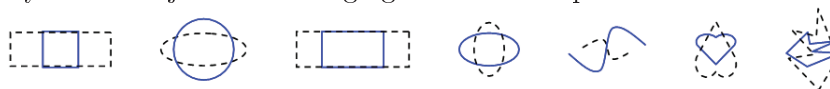
- Copying the objects only with moving.
- Objects are rotating around the handle opposite to rotate handle.

KeyĄlt":

It is used for work with grid. It causes snapping to grid even when it is turned off.

Of course, the keys can be combined and other shapes with special properties can be created.

Some examples of creating geometric figures with characteristic properties with using mentioned keys and graphical tools:

Parallel lines can be simply drawn by copying (Ctrl).

Perpendicular lines can be drawn with the tool *Rotate right/left* 90° (*Draw → Rotate or flip ...*).

Circle with the midpoint can be drawn only with the automatic shape *Oval* starting from the midpoint (Ctrl+Shift).

Axis of the segment can be drawn also in this way: At first, the original line is copied to the clipboard (Ctrl+C). Then it is rotated by 90 degrees (Shift) and then the original line is pasted (Ctrl+V). **The midpoint of the segment** can be created in the similar way.

Centrally and axially symmetrical shapes can be drawn with tools *Flip vertically/horizontally* (*Draw → Rotate or flip ...*).

Circle can be **divided into equal parts** using regular figures or stars.

Parts of the circle or **ellipse** can be drawn using the shape *Arc*.

Conic sections (except ellipse) and other **curves** can be approximately drawn with automatic shape *Curve* with various modifications of its main points. The modification can be called from *Shortcut menu* after clicking on *Edit points* and then successive right clicking on single points of the curve. There are several available point characteristics: *Automatic*, *Smooth* (Fig. 5 – tangent vectors have the same direction and length), *Straight* (Fig. 6 – tangent vectors have the same direction but different length) and *Corner point* (Fig. 7 – tangent vectors have different direction and different length) and the shape of the curve can be modified by tangent vectors on these points.

Figure 5:   Figure 6:   Figure 7:
Smooth point   *Straight point*   Corner point

Some other pictures drawn in Word:
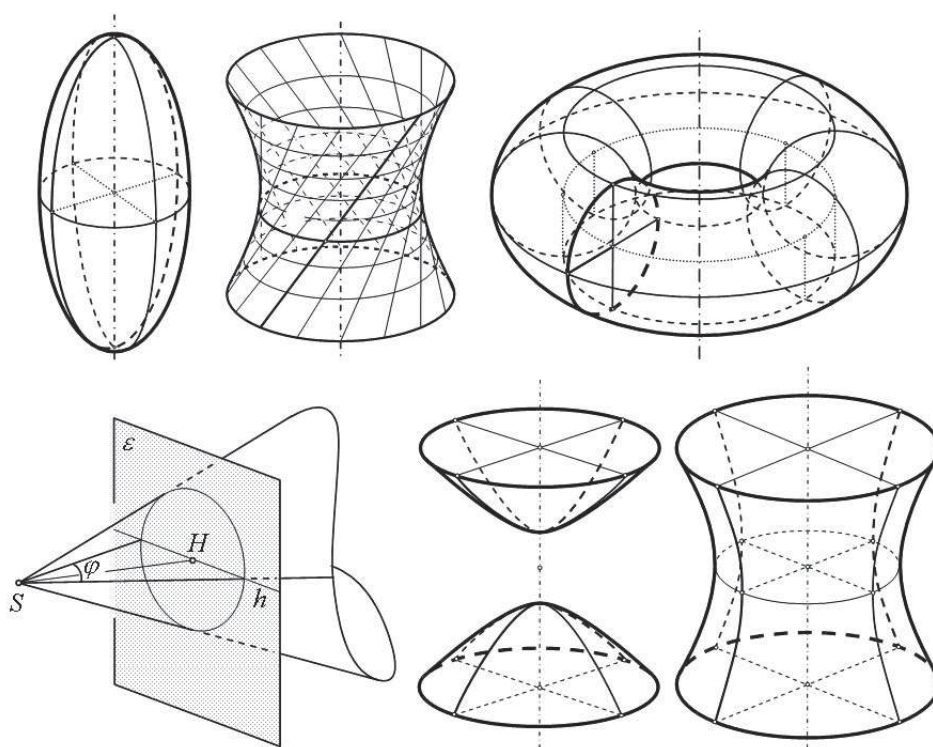
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