

Applicability of User Defined Functions in Mine Surveying

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Abstract: MS Excel is one of the most popular programs for tabular calculations. As such, it is widely applicable in mine surveying. This work shows the possibilities for creation and usage of the User Defined Functions (UDF), which can replace classic forms, but also the possibility to transfer, by using of those functions, data from Excel into the AutoCAD.

Key words: Mine Surveying, MS Excel, Visual Basic for Applications (VBA), User Defined Function (UDF)

INTRODUCTION

As we know, Excel is a program, which is a part of Microsoft Office package. It is one of the most applied programs and one of the most popular programs for tabular calculations. However, apart from processing numerical data, Excel is also very useful for the creation of charts, organization of table lists, automation of complex tasks, as well as for the data import from other programs (WALKENBACH, 2003). This all is responsible that Excel is widely applied in mining surveys, both scientific and engineer discipline, which is, apart from performance of appropriate surveys, based also on the large number of calculations of various complexity.

Excel and calculations in mining surveys

Mine surveying are a specific segment of mining science and technique. If we would like to define them in simple terms, then

this is a discipline by which necessary surveys, calculations and display of recorded mine areas and facilities on digital plans or in the form of digital terrain model are to be performed. In view of the large number of calculations of various size and complexity, the application of Excel in this stage of mining and surveying works is very significant.

During the earlier period of computation technique (logarithmic tables and pocket calculators), necessary calculations were, for the reason of uniformity, easy reference and reduction of computation errors, performed on appropriate printed patterns – forms. Those forms are being in use today, as well, however, on a much lesser scale.

Excel has got a large number of already made functions, which are divided into nine categories (database functions, date and time functions, financial functions, information functions, logical functions, lookup and reference functions, math and

1	A	B	C	D	E	F	G	H	I
2		Ta	1			Ya	7416046,76	Xa	4800562,88
3		Tb	193			Yb	7415864,59	Xb	4802352,09
4		To	199			Yb-Ya	-182,17	Xb-Xa	1789,21
5		φa	39	58	00	ΔYa	890,37	ΔXa	1062,36
6		φb	124	07	31	ΔYb	1072,54	ΔXb	-726,85
7						Yo(a)	7416937,13	Xo(a)	4801625,24
8		tg φa	0,8381087			Yo(b)	7416937,13	Xo(b)	4801625,24
9		tg φb	-1,4755911			Yo	7416937,13	Xo	4801625,24
10		C	2,3136998			$-(Xb-Xa)tg\varphi b$	2640,14	A	2457,97
11						Yb-Ya	-182,17	B	-1681,72
12						$-(Xb-Xa)tg\varphi a$	-1499,55		
13									
14									
15									
16									
17									
18									

Figure 1. First page of trigonometry form number 10, made in Excel

trig functions, statistical functions, text functions), which enable wide application of this program for various fields.

Thanks to these functions, above all regarding the categories math and trig functions and statistical functions, practically all calculations to be performed within mine surveying, regardless of their complexity, can be performed in Excel. If we add wide possibilities in organizing and formatting of worksheets, it is no problem, at all, to organize worksheets as existing forms. In this way, visual identity of forms is maintained both while working as while printing.

Figure 1 shows how the first page of the form number 10 looks like in Excel, which is used to calculate temporary coordinates of unknown trigonometric points by using the method of forward cut through (MIJATOVIĆ, 2006).

Basic element of each worksheet is the cell. There are 16777216 cells on one RMZ-M&G 2008, 55

worksheet, which are distributed in 65536 rows and 256 columns (Excel 2007 has 1048576 rows marked with numbers, i.e. the number of rows and columns is limited by the memory of the computer and by the available system resources). This is so big space, that all existing forms can be put on one worksheet and yet to have large part of the cells free. However, a worksheet formatted in such a way would be inefficient and not economical (imagine scrolling or jumping on a worksheet such like that while searching the appropriate form).

This can be resolved by adding and formatting new worksheets within one worksheet, or by formatting new worksheets. Figure 1 shows several of totally seven worksheets, that are used to perform the complete alignment of coordinates of one trigonometric point, as well as the assessment of accuracy of the survey results and coordinates of the unknown point, on the model of the form number 10.

By acknowledging the standpoint of single individuals, according to which they do not want to waste their time in order to search for the appropriate worksheet, but also by taking into account the fact that the largest number of cells is actually occupied by provisional results, which had their significance only while calculation “by hand”, brings us to the other application concept of Excel at calculations in the field of mining surveys.

User Defined Functions (UDF) for the solution of classic formulas

The other concept for the solution of the problem is based on the application of macro language called Visual Basic for Applications (VBA). The VBA macro (procedure) may be either subprogram (Sub) or a function. The Result of the VBA function is a single result, and execution of those functions is made from other VBA procedures or in the manner, which is also used by the other existing functions within the Excel itself. To put it briefly, we are going to create our own User Defined Functions within the VBA (VULIĆ, BRECELJ, 2007) and (VULIĆ, DURGUTOVIĆ, 2007), which are to be used as any other existing function.

In this way, the number of the cells used is significantly being reduced, since we need only the cells with input and output data (without hiding the columns and rows where provisional calculations are made). Also, the output data, just like the input data, may be situated anywhere on the worksheet in any cell.

VBA functions, which are newly created, are stored in files with the extension *xla*. Those files are the so called Microsoft Excel VBA Add-In files, to which modules, functions or other tools are to be added, and which are created by users.

The download of those files into Excel may be performed in two ways:

- open the new, empty worksheet, select with *Save As* from the menu *File*, choose option *Microsoft Office Excel Add-In (*.xla)* and set the desired name and location;
- if the desired *xla* file already exists somewhere in the computer, the download is to be performed from the menu *Tools*→*Add-Ins*.

After file download, function writing or correction of the functions already existing is to be performed in VBA editor, which is accessible from the menu *Tools*→*Macro*→*Visual Basic Editor* or by pressing key buttons *ALT-F11* (Figure 2).

The possibility of solution of particular formulas within the mining surveys will be, for the purpose of comparison, shown on the example of calculation of temporary coordinated of a trigonometric point by using the method of forward cutting. Function *TO10nap* has the following shape:

Function TO10nap(ya As Double, xa As Double, yb As Double, xb As Double, fiast As Integer, fiamn As Integer, fiase As Double, fibst As Integer, fibmn As Integer, fibse As Double) As Variant

Dim fiadec As Double, fiarad As Double, fibdec As Double, fibrad As Double

Dim a As Double, b As Double, c As Double

Dim yoa As Double, yob As Double, yo As Double

Dim xoa As Double, xob As Double, xo As Double

Dim toOut(1) As Double

Dim ro As Double

ro = 57.29577951

```

(General) (Declarations)

x0 = xb + ((a / m) * a)

toOut(0) = yo
toOut(1) = xo
TO10naz = toOut

End Function

Function TO10lp(ya As Double, xa As Double, yb As Double, xb As Double, da As Double, db As Double) As Variant
Dim d As Double, p As Double, q As Double, ha As Double, hb As Double, h As Double
Dim yoa As Double, xoa As Double, yob As Double, xob As Double
Dim yo As Double, xo As Double
Dim toOut(1) As Double

d = Sqr((yb - ya) ^ 2 + (xb - xa) ^ 2)
p = d / 2 + ((da ^ 2 - db ^ 2) / (2 * d))
q = d / 2 - ((da ^ 2 - db ^ 2) / (2 * d))
ha = Sqr(da ^ 2 - p ^ 2)
hb = Sqr(db ^ 2 - q ^ 2)
h = (ha + hb) / 2

yoa = ya + p * ((yb - ya) / d) + h * ((xb - xa) / d)
xoa = xa + p * ((xb - xa) / d) - h * ((yb - ya) / d)

yob = yb - q * ((yb - ya) / d) + h * ((xb - xa) / d)
xob = xb - q * ((xb - xa) / d) - h * ((yb - ya) / d)

yo = (yoa + yob) / 2
xo = (xoa + xob) / 2

toOut(0) = yo
toOut(1) = xo
TO10lp = toOut

End Function
    
```

Figure 2. Preview of VBA Editor with the function TO10lp for calculation of temporary coordinates by using the method of arch cross section

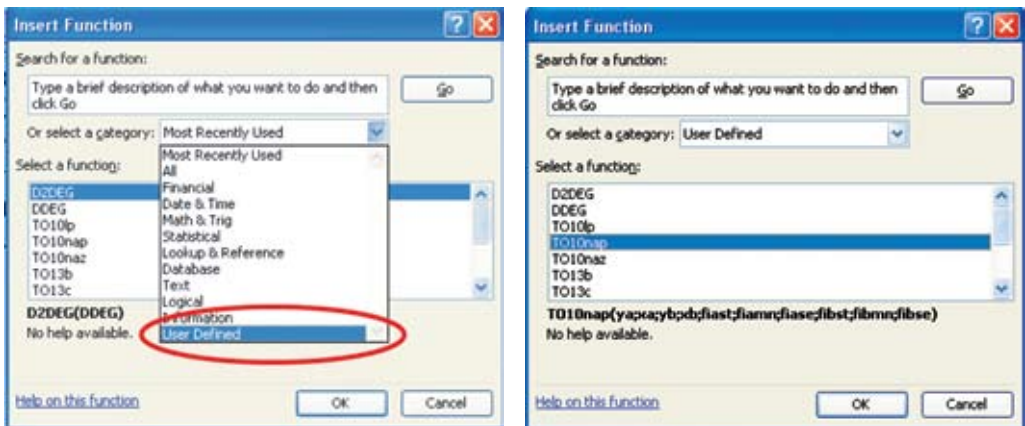


Figure 3. Download of the TO10nap function

```

    fiadec = fiast + fiamn / 60 + fiase /
3600
    fiarad = fiadec / ro
    fibdec = fibst + fibmn / 60 + fibse /
3600
    fibrad = fibdec / ro
    a = (yb - ya) - (xb - xa) *
Tan(fibrad)
    b = (yb - ya) - (xb - xa) *
Tan(fiarad)
    c = Tan(fiarad) - Tan(fibrad)
    yoa = ya + (a / c) * Tan(fiarad)
    yob = yb + (b / c) * Tan(fibrad)
    yo = (yoa + yob) / 2
    xoa = xa + a / c
    xob = xb + b / c
    xo = (xoa + xob) / 2
    toOut(0) = yo
    toOut(1) = xo
    TO10nap = toOut
End Function

```

The function *TO10nap* is to be requested in the same way as any other already existing Excel function. By clicking on the icon for *Insert function*, which is on the Toolbar, a window for the selection of a category, where the function can be found (newly formed category *User Defined*) appears. After this, in the next window, the selection of the function from the selected category (figure 3) is made. Subsequently, in the next window (figure 4), the arguments of the function, i.e. worksheet cells, where those arguments are located, are entered. In this case, the coordinates y and x of the given points A and B , as well as oriented directions of given points in relation to the unknown are entered. Since the degrees, minutes and seconds of oriented directions are located within the separate cells, it is necessary,

while entering arguments of this function, to locate ten cells, in which said input data are located, which is also shown by the afore mentioned procedure of this function.

As the result of those activities, the coordinates of the unknown trigonometric point (figure 5) will be obtained within previously marked cells for which we want the printout.

As partially shown by the figure 3, the procedures for calculation of temporary coordinates of trigonometric points by using the method of backward cutting *TO10naz* and by using arch cross cutting *TO10lp* (figure 2) are also written within those UDFs. Furthermore, functions for calculation of both grid bearings of sides *TO8ni* and horizontal lengths between side *TO8ni* defining points are also written. Functions, which are used to solve triangles by using sine or tangent theorem, are also made (*TO13b*, *TO13c*, *TO13gama*, *TO14a*, *TO14beta*, *TO14gama*). Those functions are used to calculate separate elements of triangles, and there is no connection between them in terms of obligation to maintain some order of calculation or obligation to calculate all elements. Due to the size of this function, they are not shown during work.

Data transfer from Excel into AutoCAD

As already said at the beginning, one of the main tasks of mining surveys is also to display the space or the facility recorded in form of digital cards and plans or in form of a digital terrain model. AutoCAD is a standard for the development of digital plans as well as other technical drawings, so that, in terms of mine surveyings, the idea of connecting Excel and AutoCAD

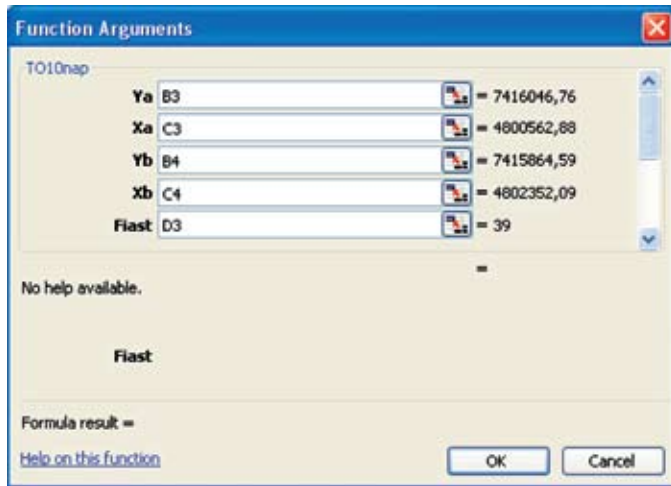


Figure 4. A part of entry of the arguments of the function TO10nap

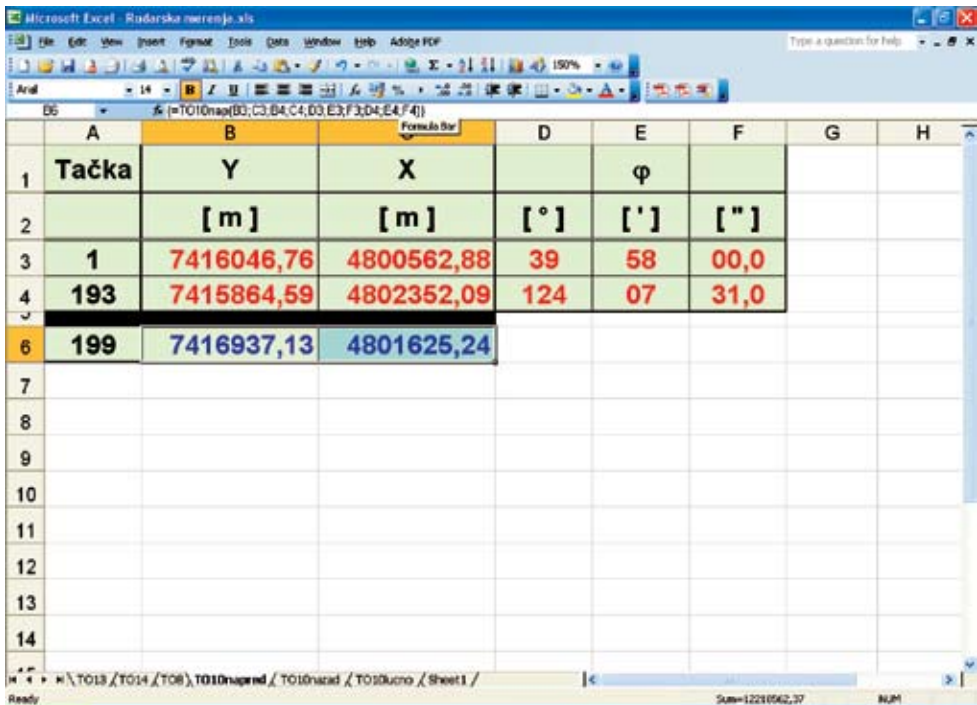


Figure 5. Preview of a worksheet, in which the function TO10nap was used

is very interesting. Our desire was to use large calculation potentials of Excel, i.e. to export those calculated data into AutoCAD.

A program called XLPoint Plus, which is intended for the plotting of large number of points by using AutoCAD and 3D model generation by using of coordinates of points in Excel can be found on the Internet. Since this program is not free to download, UDFs were written, which, by complying with the syntax of AutoCAD, group the corresponding data from cells and practically write down the AutoCAD commands in Excel (points with UDF *pointW*, lines with *lineW*, ellipses with *ellipseW*, etc) (<http://www.geo.ntf.uni-lj.si/mvulic/udf/vule4acad.xla>).

Subsequently, the corresponding cells – commands are copied (*Ctrl+C*), AutoCAD is being opened and, within the command line, copied commands (*Ctrl+V*) are being transferred. At the same time, copied points, lines, circles, ellipses, etc are being plotted in AutoCAD.

CONCLUSIONS

MS Excel, a program for tabular calculation, has a very significant place within mine surveying today. It is able to perform not only some auxiliary calculations, but also the complete solutions for corresponding problems, as well as complex equalizations based on matrix

calculus. All of this opens the possibility for Excel to be alternative in situations where there is no corresponding application software available.

The objective of this paperwork was to show that the User Defined Functions may also be used for more complex calculations, i.e. that the use of one or several functions created in this way can replace the entire classic calculation formula. Of course, this requires that the user has a certain elementary foreknowledge in the field of programming.

Due to its size, some functions are completely shown, and some of them are only mentioned, namely those who are able to show all benefits of the UDF in the best way possible. In other words, functions replacing those so called “trigonometric formulas”, which are most frequently used in mining surveys, are shown and thus is the autonomy, simple application, but also the ability and reliability of functions created in this way is demonstrated.

This is just one of the methods to solve problems related to calculations in mine surveying. Each user shall for him/her, depending on his/her expertise, ability and the desire, define how to solve a particular problem.

At the same time, it is necessary to emphasize again, a very simple method, by which calculated values can be moved into AutoCAD and to show calculations, but also measurements, in 2D or 3D.

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