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Introduction to MS Excel advanced techniques via e-learning

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Abstract

The starting point to solve certain technical problems is creating a suitable model that reflects features of modelling reality and provides the means and tools how to find the best solutions. It can be created using specific approaches and different application tools. The use of advanced techniques of select application software, however, is time consuming. To obtain the necessary skills and knowledge it is necessary to solve many tasks. The standard approach gives to students only basic guidelines. In this case, it is possible to use e-learning resources and create documents for students to were more able to work independently. In this paper will be described the possibilities of using the MS Excel to creating a simulation model for the analysis of static characteristics of the selected artificial muscles. This manner describes the using of some advanced techniques and can serve as an introduction to the programming language MS Excel -Visual Basic for Application.

Keywords: Model; MS Excel; visual basic for application.

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1. Brief description of Required Task

Artificial muscle is a kind of actuator generally defined by analogy with the skeletal muscle. Like the natural muscle, any artificial muscle is characterized by its ability to contract in response to a chemical or physical stimulus (Tondou, 2015). Pneumatic artificial muscles (PAMs) have several advantages over other types of actuators, but most of all it is their power-weight ratio and usage in rough environments. Pneumatic artificial muscles are suitable for application in stationary and mobile devices, where both low weight and low cost at either standard or exceptional (Vagaska, 2014). Pneumatic artificial muscles are contractile devices operated by pressurized air. Their core element is an inflatable membrane. When pressurized, they inflate, shorten and thereby generate a contraction force.



Figure 1. Artificial muscles

This force depends on the applied pressure and on the muscle's length, ranging from an extremely high value at maximum length, i.e. zero contraction, to zero at maximum contraction or full inflation (Daerden, 2001).

We want to create a simulation model to analyse the dependence of the load force on muscle contractions. The task is to progressively render dependences into one graph when the input data is changed. We will use the mathematical equation describing the required dependency (Pitel, 2015).

$$F = p \frac{3l_0^2(1-\kappa)^2 - b^2}{4\pi N^2}$$

There we assume the geometric constants of the system b fibre length, N number of a fibre orbs provided in extensibility of fibres of braiding and l length of muscle, p is pressure and κ is contraction. It results from the relation that the tension force is directly proportional to the air pressure inside the muscle and it is the function of the angle of fibres.

2. Processing of Task

We divide the required task into separate stages that students will perform. All stages, except the first, will also have the text support in .pdf format. The student will be able to return to individual stage. The manners described in these stages are general, so it is possible to apply their on other tasks.

2.1. Stages description

The aim of experimenting with the simulation model is mostly the comparison of possible variants. We evaluate the output value of the simulation model (or more output parameters) (Jerz, 2010). We create a simulation model using the tools of MS Excel and program language VBA.

- The first task for students is to create a graph using traditional way. That means to get the value of the dependent variable according to a mathematical formula. At this stage, we consider the constant

$b = 277.1$ mm, $N = 1,5$ and the length $l = 264$ mm. We have written all this data in cells in the Excel. The creating a plot is one of the basic skills in MS Excel and we assume no problems with this task.

- The next stage we create a dynamic plotting by varying the pressure. In this case, we use only the active elements of the "Developer". We use the drop-down menu and we link it to the appropriate cells (Fig.1 and Fig.2). Using this drop-down menu we will change the input value of pressure.

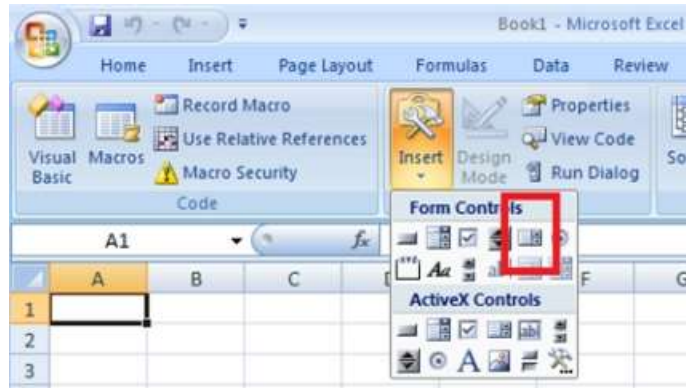


Figure 2. Form Controls

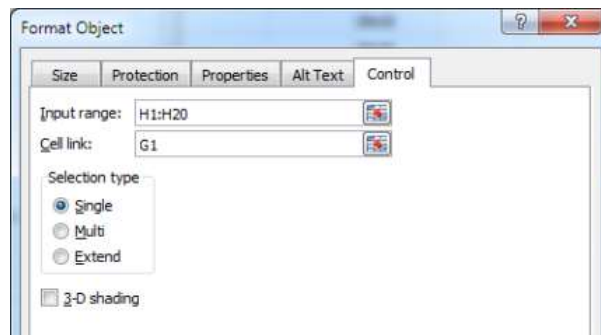


Figure 3. Selection of cells

We will use the possibility of an *if* statement in order to ensure a dynamic change to the calculation of dependent variables.

$$=IF(F1=1;0;IF(F1=2;100;IF(F1=3;200;IF(F1=4;300;IF(F1=5;400;500))))$$

If we change the input data the data forming the graph will be automatically changed. For this reason it is necessary to press F9 for the current data series in the chart.

$$=SERIES(;Hárok1!H2:H18;Hárok1!I2:I18;1)$$

This ensures that the change of the input data does not automatically change the actual graph. The next figure represents this graph.

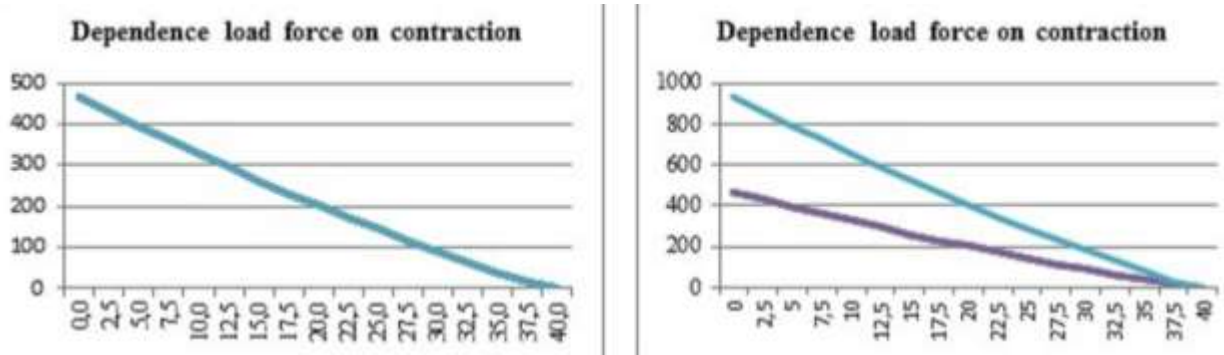


Figure 4. Creation of graph

- We create a simple user window where we will ask the input values. We use the command Input and the values we put into cells in MS Excel. It is a first time when the students begin working in environment of VBA. There is needed a brief introduction to describe the environment of VBA and give the students the necessary basics with creating code.

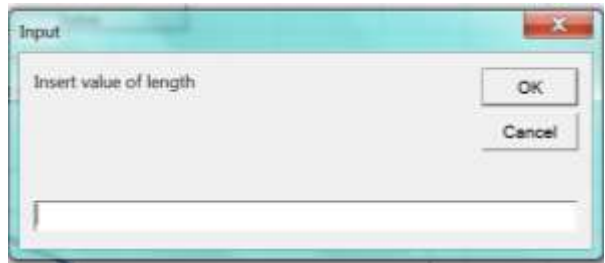


Figure 5. Input window

- We describe the possibilities of creating macros in MS Excel. As example we use the possibility of creating a known graph. The students already create this graph, so they can use the possibility "Record Macro" and they can repeat the steps of graph creation. In order to verify the functionality of macros, we show the different way how to run of macro.

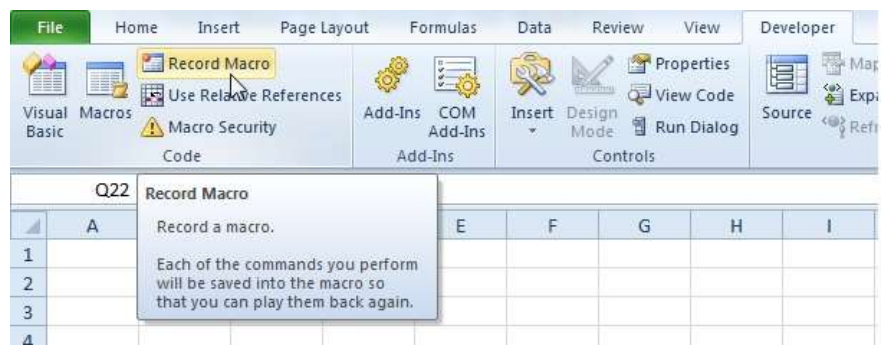


Figure 6. Record macro

- We create the code that will determine the range of independent variables and solve an output value according to mathematical expression. We will use the selected command of cycle and the

possibilities of working with the object Range. This section will be continued in the initial code. After a successful running and debugging, we can "call" macro and render a graph.

```

For i = 3 To 18
Cells(i, 1) = Cells((i - 1), 1) + 2.5
Next i
Range("b1") = "Force"
Range("b2").Formula = "=( $\$e\$1 * 1000$ )*((3* $\$e\$2^2 * (1 - (a2/100))^2 -$   

 $\$e\$3^2$ ))/(4*PI()* $\$e\$4^2$ )"
Range("b2").AutoFill Destination:=Range("b2:b18")
datgraf1 'name of macro
    
```

The following figure shows the resulting window after performing the previous steps.

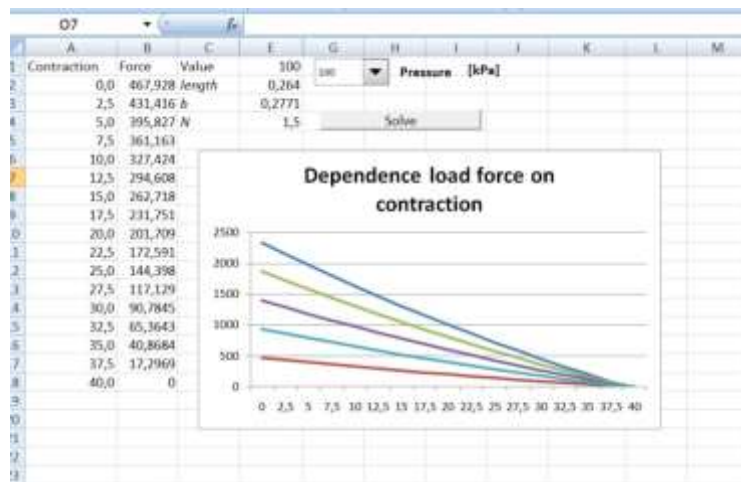


Figure 7. Final window

We plan using a Learning Management System (LMS). It has become very popular among educators around the world as a tool for creating online dynamic web sites for their students (LambaSolution). Students will download necessary files with the tasks. Individual activities and requirements for processing will be given to students through Moodle interface, where the appropriate course will be created. Individual supporting materials and tasks for students will be inserted here gradually. There will be uploaded the text documents, video and new tasks to repeat gained knowledge

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