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## RECOMMENDATIONS FOR THE DISPLAY AND ANALYSIS OF THE RESULTS OF MULTIPARAMETER RESEARCH IN HARDWARE AND SOFTWARE ENVIRONMENTS

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Increasingly, it is necessary to analyze and process the results of multiparameter research of the objects geometric and optical properties at the control and testing of products. The capabilities of modern software and hardware environments allow you to implement these procedures. The purpose of this work is to analyze the capabilities of modern software products from the standpoint of effective 3-D modeling of the results of multiparameter research.

1. Software product of Waterloo Maple Inc. (Canada) Maple is used for analytical mathematical calculations, data visualization, and modeling. Maple has a built-in plot3d function in the kernel for plotting three-dimensional surfaces. There is a possibility to specify the types of coordinate systems using the transformation formulas from a rectangular coordinate system to another, i.e. transformation  $(u, v, w) \rightarrow (x, y, z)$  [1]. To build a graph, we need to set the equation of the function (in explicit or implicit form) and then the program will display its three-dimensional image. The plot3d function allows you to build several shapes that intersect in space at the same time. To do this, instead of describing one surface, we need to specify a list of descriptions of a number of surfaces. An example of such construction for two functions is shown in the figure 1.

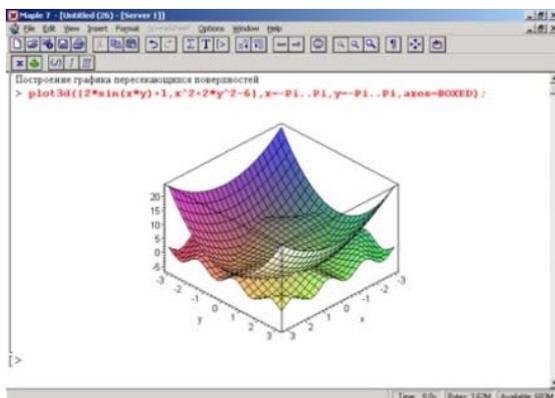


Figure 1 – An example of the construction of surfaces in the environment Maple

Also, special three-dimensional structures can be used, such as GRID (specifying the surface over a portion of the coordinate plane bounded by segments  $[a, b]$  and  $[c, d]$ , according to the data specified by the variable-listlist, see figure 2) or MESH (specifying the data of the listlist variable, which contains the full coordinates of all surface points, it is possible to specify the last one in case of uneven grid).

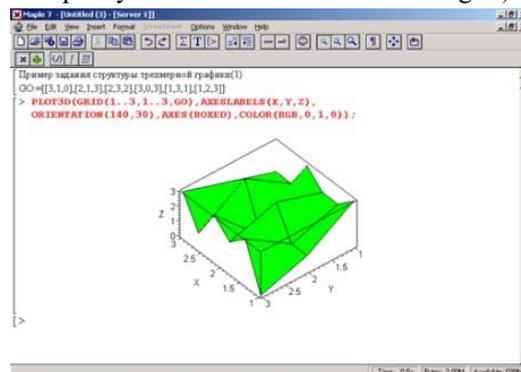


Figure 2 – Example of creating A grid-type graphical structure

2. Software product Mathcad company Parametric Technology Corporation is universal for mathematical modeling and solutions of mass various fields of science and technology. In the Mathcad environment, there are actually no function graphs in the mathematical understanding of the term, but there is a visualization of data located in vectors and matrices (both lines and surfaces are plotted by interpolated points).

Mathcad easily integrates with a huge number of databases and third-party SOFTWARE including Microsoft Excel, MATLAB by MathWorks, etc. The ability to use in the calculation of quantities with dimensions in different systems of units is an advantage of this environment [2]. The results of the calculations also obtain the corresponding dimension. This fact greatly simplifies the tracking of errors in physical and engineering calculations. Two-dimensional (2D) and three-dimensional (3D) graphics are used to display and interpret the calcu-

lation results. Two-dimensional graphics implies a graphical representation in the Cartesian (coordinates  $[x, y]$ ) and polar (coordinates  $[r, \varphi]$ ) coordinate system. 3D graphics is used to build three-dimensional surfaces (Surface Plot), contour plots (Contour Plot), 3D histograms (3D Bar Chart) and other three-dimensional objects.

To plot the surface in a certain area of change of independent variables or with a specific step of their change, it is necessary to set the node points  $x_i$  and  $y_j$  which the values of the function will be determined in, and then define the function  $f(x,y)$ , the schedule must be built. After that, it is necessary to form a matrix of function values in the form of:

$$A_{i,j} = f(x_i, y_j). \quad (1)$$

After the command Insert→Graph→Surface Plot we enter the name of the matrix in the graphics area that appears without indexes. An example of plotting a graph in Mathcad is shown on figure 4.

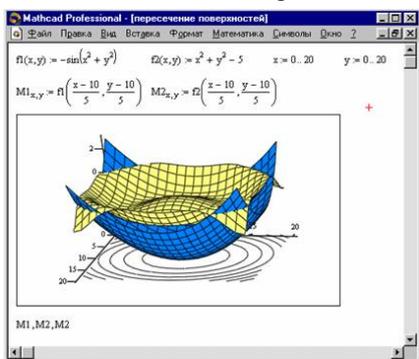


Figure 4 – Graph Display in Mathcad

3. MATHEMATICA is Wolfram Research's computer algebra system, which is one of the most powerful and widely used integrated multimedia software systems and recognized as a fundamental achievement in the field of computer design. [3] The system provides calculations with any given accuracy; construction of two- and three-dimensional graphs, their animation, drawing of geometric figures; import, process, export images and sound. The main opportunities for 3D data visualization and graphing of dependencies 3 or more quantities represented by the following functions ([4], [5]). Plotting a 3D graph of the function of two variables  $f(x, y)$  is performed using the Plot3D function (see figure 5):

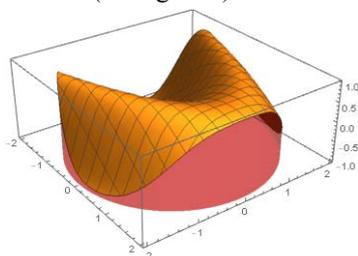


Figure 5 – Visualizing the function of two variables in MATHEMATICA

The ListPlot3D function is used to plot a three-dimensional scatter plot of data, the ListDensityPlot3D function is used for the three-dimensional plotting of the  $f(x,y,z)$  function. The VectorPlot3D function allows you to display vector field graphs over a dataset, and the ListVectorPlot3D function is used to display experimental or simulated 3D data. The SliceVectorPlot3D function is used to display the cross section of a vector field of a given function by some surface. If the field function is unknown but the dataset is present then the ListSliceVectorPlot3D function can be used. The AnatomyPlot3D function is responsible for visualization three-dimensional graphical representations of anatomical units (figure 6).



Figure 6 – Visualization of anatomical units 3D-models in MATHEMATICA

In addition to extensive visualization capabilities of three-dimensional data Wolfram Mathematica has a powerful system of analysis and processing of the results of multiparameter research of the objects geometric and optical properties at the control and testing of product. Operations on these multidimensional data are possible not only in rectangular Cartesian, cylindrical and spherical coordinates, but also in arbitrarily specified coordinate systems due to the support of affine transformations. The considered software products are an effective application tool for high-resolution colorimetry in software and hardware environments.

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