Computer analysis of continuum mechanics and civil engineering problems is common and widespread issue for many years. Due to it, it is possible to obtain approximate solutions of many complicated and complex problems, for which no analytical solution exists - which may be obtained with pure mathematics. Therefore, today's engineer, apart from the principles of design and execution of buildings' technical documentation, is obliged to know the rules of operation the latest computerized systems of engineering calculations. It is not the knowledge of the software itself that is the most important here. Understanding of the models (mechanical, mathematical, numerical), on which they are based, as well as to the correct interpretation of the results count the most.

Among many methods for modeling of engineering problems, the two most commonly used approach is the finite element method (FEM) and finite difference method (FDM). In both methods, one does not consider the entire problem domain at once (which can be, for instance plate, shield, shell, beam). It is divided (discretized) into separate points called nodes. Nodes are sufficient to start the calculation by means of FDM (especially in its meshless version - MFDM - in which nodes may be distributed totally irregularly). In turn, the FEM requires the additional generation of simple figures or geometric solids with nodes at their vertices (triangles, quadrilaterals, cubes, tetrahedrons) - the so called finite elements. This difference in discretization between FEM and FDM is of great importance in the later stages of numerical analysis. It must be made very precisely, so that the cloud of nodes or mesh of elements fits to the problem domain, taking into the account all straight and curved edges, holes, cracks and corners. Therefore, an important part of this project is development of the effective FEM generator, taking into account the user-defined division into subdomains.

In this project, we decided to combine both methods in one domain, rather than opposing one another. Each method has its advantages and drawbacks. Let us try to use their strengths best as it is possible. On the other hand, let us try to eliminate or at least reduce their drawbacks. For instance, FEM produces better quality solution (displacements), when compared to the quality of its derivatives (strain, stress). For MFDM, the inverse situation occurs. As a result, it will be possible to create a new combined FEM / MFDM solution approach, which will allow for faster, more efficient and more accurate analysis of selected problems.

Among many possible problems of engineering nature, the project will focus on thermoplastics issues. We assume that the structure is made of a material which specifically reacts to the subjected load - namely, the permanent, irreversible effects occur. In addition to that, the structure response to an applied load as well as material parameters may be time- and temperature-dependent. This coupled analysis requires the introduction of several thermal and mechanical fields and combination of those fields together into one formulation. Let us also remember about the main idea of the work - coupled are not only physical fields (temperature, displacement) here, but also the methods of computer analysis (FEM / MFDM).

When we eventually obtain the solution of such double-coupled problem (at the level of mechanical and numerical modeling), we must be sure of its quality. Therefore, in this work , we will analyze the error of such a solution, developing methods for its estimation. In addition, we will try to refine the FEM nodes (for MFDM) / nodes and elements (FEM), modifying their location and numbers, integrating it into the solution process. In this manner, we pay special attention on reliability of engineering calculations, which is an extremely important branch of today's worldwide computational mechanics.