New features of AutoFEM version 1.5

New possibilities of the Preprocessor

Creating Studies

Working with AutoCAD layers. A new possibility to flexibly manage the composition of the bodies involved in the study has emerged, and AutoCAD layers are used to this end. Now only objects located on visible layers are added to the Study. Objects located on invisible (hidden) layers do not fall in the study.



Objects, placed on turned off layer, are not included in the study

Draft dimensions. Now AutoFEM automatically perceives the geometric model in length units set up by the user in AutoCAD with the help of the UNITS command. Earlier, the dimensionality of a geometric model was set in AutoFEM regardless of AutoCAD. Besides, a new unit of length, feet, is added.

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Now AutoFEM's model units automatically correspond to AutoCAD's units

Naming bodies in the study. The order of identification of the bodies involved in the study is changed. Now, the name (unique for each study) is assigned to each body included in the study. When the composition of the

study objects is changed, names of the bodies which are still included in the study do not change. This simplifies the discovery and correction of errors in geometric models in the studies.

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The new naming system of bodies in the study makes editing the study more convenient

Promptitude is improved. The velocity of the work of the Preprocessor window is significantly improved concerning the opening of complex assembly models with a great number of solid-body objects (hundreds of parts). Geometrical data about the calculated model are now saved in file .dwg that speeds up the opening of the earlier saved studies.

Automatic correction of intersections. When the study is created, the check of body intersections is carried out. The matter is that no correct finite-element study can be created if the intersecting bodies are involved. In fact, at intersection of bodies, it happens that at one point in space, e.g., two different materials belonging to different bodies may be determined that is physically impossible. In previous versions of AutoFEM, the user had to remove the intersections manually, using AutoCAD commands. The new version is capable of launching the automatic removal of body "crosses" in the model.





Removing the intersections for successful meshing

Study diagnostics. A new command, Study Diagnostics, is designed to help the user find erroneous objects in the study and test the correctness of a 3D model of a part from the point of the finite-element modeling on the whole. The command is performed automatically if the Preprocessor finds mistakes in the process of study creation. The following diagnostic modes are available:

 Mode Multi-volume bodies reflects multi-connection bodies if any in the study. The multiple-connection body is the term meaning the AutoCAD object which consists of several non-contacting volumes. Multivolume bodies are perceived by AutoCAD as single object. One requirement set by the AutoFEM Preprocessor is the one-volume nature of solid bodies involved in the study, i.e. one closed area in the 3D space must correspond to a single body.

Diagnostics mode Multi-volume bodies	Stud
 Non contacting bodies Intersections of the bodies Show the contacts between the bodies Group of the bodies: 	the study
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Image of the multi-volume body

 Mode Non contacting bodies reflects groups of bodies not having physical contact with other bodies. In some cases, the presence of independent groups of bodies in the study can indicate incorrectness of the problem setting.

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Non-contacting groups of bodies

Mode Intersections of the bodies illuminates pairs of intersecting bodies. Creating the finite-element mesh for the intersecting bodies is not permitted. Actually, the read solid-body physical object does not permit the presence of more than one body and material at one spatial point



Reflecting pairs of intersecting objects in the Preprocessor window

Mode Show the contacts between the bodies reflects all facets by which the bodies contact with each other in the Preprocessor window. Using this command, you may check whether the determination of the body contacts by the Preprocessor is correct or not.



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Geometry:

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Creating the finite-element mesh

The new dialogue of controlling the finite-element mesh generation.

The new version of AutoFEM has a completely reworked interface of managing the generation of the finiteelement mesh. Now the control over the mesh generator is performed using a special palette, similarly to the work of most other AutoFEM commands. The new interface allows the user to interactively manage the construction of the finite-element mesh, in particular, to set condensations on edges and facets of the models, as well as specify parameters of division for specific bodies. Command "Apply" generates the mesh but the dialogue of the command does not close at that. The user is able to estimate the mesh quality and return to editing its parameters when necessary.



New interactive dialog of mesh generator

Management of parameters of the finite-element splitting. The new version has the capability to control the degree of finite-element splitting individually for different elements of a solid-body model. One can set the preferable length of the edge of a finite element near the specified set of edges, set facets or a 3D body.

Finite Element Parameters	
Condensation of the mesh	
Geometry:	
Body 5 Face 2 Edge 4 Edge 3	
Edge length: 20.000 mm	
10% 1	
Show errors Apply	

Using the tools of mesh condensation

The dialogue of statistics of the finite-element mesh. One may assess the mesh quality not only visually but using a special command, "Show detailed information", available in the dialogue of mesh generation control. This dialogue graphically reflects the quality of the shape of tetrahedron finite elements by several parameters.

Advanced Mesh Info	
Mesh quality statistic	Aspect ratio histogram
Node Count 1192 Element Count 2099 Smallest volume: 7.05717 Largest volume: 316.667 Shortest edge: 5 Longest edge: 23.6854 Smallest aspect ratio: 1.41421 Largest aspect ratio: 1.41421 Largest aspect ratio: 10.1546 Smallest face angle: 19.4712 Largest face angle: 126.87	< 1.5
Face angle histogram (angle degrees) 0 - 10 0 10 - 20 118 20 - 30 958 30 - 40 970 40 - 50 2220 60 - 60 1222 60 - 70 861 90 - 100 1051 90 - 100 1990 100 - 110 137 110 - 120 163 120 - 130 160 130 - 140 164 140 - 150 165 150 - 160 160 160 - 170 0 170 - 180 0	Dihedral angle histogram (angle degrees) 0 - 5 0 5 - 10 10 - 20 107 20 - 30 407 30 - 40 365 40 - 50 218 60 - 70 143 70 - 80 0 80 - 110 124 3 110 - 120 373 120 - 130 106 130 - 140 178 140 - 150 116 130 - 140 178 140 - 150 116 136 170 176 180 170 175 0
Optimal shape of tetrahedrons	Non optimal shape of tetrahedrons

Detailed mesh statistics window

Visualization of erroneous objects. Sometimes, as a result of mesh construction, too flat tetrahedron elements are formed, with all four vertices lying in virtually one plane. Usually such elements can emerge at construction of a simplified mesh without control over the elements' quality (mode Thin-walled structure, the Mesh quality set as "disable"). At the stage of pre-computed preparation, these elements are excluded from the set model. Now, if the model has such elements, button "Show errors" starts to be activated. When pressing it, erroneous elements are seen in the Preprocessor window. If such elements are too many, results of the calculation may be misrepresented; therefore, one should avoid too large a number of flat elements in the mesh model.

Finite Element Parameters	
Condensation of the mesh Geometry:	
Edge length: 19.120 mm	
Show errors Apply	

Erroneous finite-elements in Preprocessor window

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New possibilities of the Postprocessor

The new report generator. The generator of html-reports on studies is completely reworked. Now reported are fuller data about study settings, boundary conditions, and materials as well as graphs and tables carrying data values from sensors. In addition, now the user can save a 3D result model as the report (in format vrml) while saving all color information about the result. To view the result in 3D, one should use the free off-site plugin, Cortona3D Viewer (http://www.cortona3d.com/Try-Buy/Downloads.aspx).

Results				
Displacement, magnitude [1]				
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	Max	9.06916E-008		
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	Sensor 18	5.00815E-008		
	Sensor 19	5.00863E-008		
	Sensor 20	5.00853E-008		
	Sensor 21	5.00894E-008		
	25	100		



Sensors and 3D image of the result are included in study's report

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Sensors



The sensor, which does not contain the result, e.g. does not lie on the model, is now marked by the red frame.

Sensor, marked by the red frame, does not contain the result