

WIPL-D Pro CAD: What is New in v2020?

New features/improvements introduced in v2020 are:

- 1. Accelerations of the CAD modeler:**
 - a. Project tree reconstruction
 - b. Rendering
 - c. Select operations
 - d. Validation
- 2. Improvements in the meshing algorithm:**
 - a. Reduction in the number of mesh elements from 10% to 50%, significantly decreasing the number of unknowns
 - b. Improvement in pre-meshing of complex faces
 - c. Overall acceleration of the meshing process
- 3. Introducing a Material library with over 80 predefined materials, and three new ways to define frequency dependent material properties:**
 - a. Frequency table
 - b. Cole-Cole approximation
 - c. Djordjevic-Sarkar approximation
- 4. New selection mode options:**
 - a. Select all faces connected with the selected one
 - b. Select bodies by size
- 5. Local settings:**
 - a. Distributed loading on body level
 - b. Reference frequency on the level of body, face and edge of wire bodies
- 6. Preview of the model on Open**
- 7. Remote Run**
- 8. Other options/improvements:**
 - a. AutoSave
 - b. Automatic selection of a laminar (open) loop in the Fill Hole operation
 - c. Symbols table is non-modal and dockable
 - d. Setting radiation pattern and near-field by setting step per angle and length

...

1. Acceleration of the CAD modeler

Dealing with extremely complex models, consisting of a huge number of entities, was relatively difficult and time-consuming in the preceding versions of WIPL-D Pro CAD. The new version brings significant accelerations in both, modifications of the model and its validation, making them fast and smooth and greatly improving the experience when working with very complex models.

The highest acceleration is achieved in project tree reconstruction, where certain operations are accelerated up to two orders of magnitude. The user can now comfortably enjoy all of the benefits when working with the project tree and entity/command property lists.

Significant speed-ups are also obtained in all rendering operations, as well as in selection of model parts. Various selection methods, starting from select by single click, through selection by window, to some advanced selection modes are all working much faster in the new version.

Model Validation, which is performed by default before the EM simulation, is significantly accelerated. For majority of models validation time was not critical even in previous versions. Nevertheless, for very complex models consisting of a large number of entities and especially those containing a high number of regions and wires, determination of the region where a wire is immersed was a long process. This part of the validation process is accelerated up to 100 times, making validation time negligible in the entire process of preparing a model for EM simulation and subsequently executing the EM simulation.

2. Improvements in the Meshing Algorithm

Improvements and optimizations are made in all critical parts of the meshing algorithm.

a) Improvements in Pre-Meshing

Pre-meshing is a process of subdivision of all faces of a structure to quasi-planar sub-faces. In order to obtain a very accurate representation of the original geometry, as well as a high-quality factor of mesh elements, the sub-divisions have to be performed along the lines of principal curvature of the original faces. Additionally, in order to minimize the number of mesh elements in the final mesh, the quantity of quasi-planar sub-faces has to be minimized.

By applying special techniques for the initial sub-divisions both of the above-mentioned requirements are met. The improvements in the pre-meshing algorithm are especially pronounced when dealing with complex faces, defined by high-order NURBS surfaces. In the case of complex NURBS surfaces the analytical definition of the surface and positions of the knots are taken into account when determining division parameters.

An example of a very complex face could be a human head shown in Fig. 1, where one half of the head is modeled by a single face (the highlighted one). Quasi-planar sub-faces created in WIPL-D Pro CAD v2019 and v2020 are shown in Fig. 2. The number of sub-faces is reduced from 144 in the previous version to 120 in the new version, which amounts to a reduction of about 20%. In addition, the sub-divisions are now distributed more favorably yielding a better fidelity of the modeling for very curved parts like those around the eyes.



Fig. 1. CAD model of a human head.

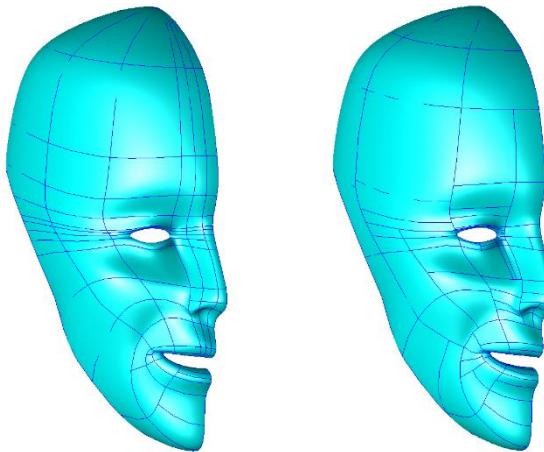


Fig. 2. Sub-division in v2019 (left) and v2020 (right).

b) Insertion of auxiliary parity points

In order to create an all-quad mesh, without any triangular elements or triangular gaps, the number of segments over closed loops of sub-faces of sub-divisions has to be an even

number. Auxiliary parity segments are inserted to poly-line representations of some edges in order to obtain parity in the total number of segments over the closed loops. The new algorithm for insertion of auxiliary parity segments includes:

- Improvements in previous local algorithms performed on the level of a vertex and a pair of adjacent vertices;
- The new global algorithm for elimination of auxiliary parity segments over the closed poly-chords and poly-chords that finish on laminar edges on both poly-chord ends. Poly-chord is a set of connected chords, where a chord is a line connecting two edges that have auxiliary parity points and that belong to the same face.

The new algorithms bring significant reduction in the total number of mesh elements, as well as an increase in the mesh quality factor. This is illustrated on a model of a cross-slot array shown in Fig. 3. The array consists of 51 slots. Total number of mesh elements and unknown coefficients in WIPL-D Pro CAD 2019 and WIPL-D Pro CAD v2020 are given in Table 1. Illustration of mesh differences between the two versions is shown in Fig. 4 for a short segment of the array.

Table 1. Number of mesh elements and unknown coefficients.

Version	Number of mesh elements	Number of unknown coefficients
2019	7,711	29,853
2020	4,608	21,854

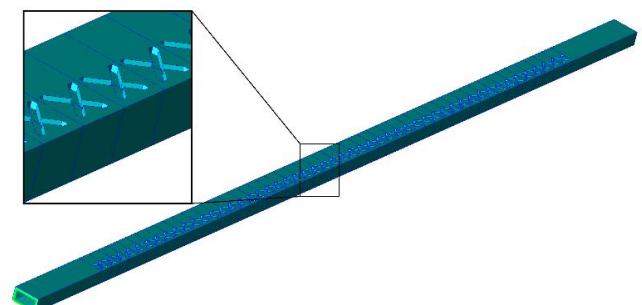


Fig. 3. WIPL-D Pro CAD model of a cross-slot array.

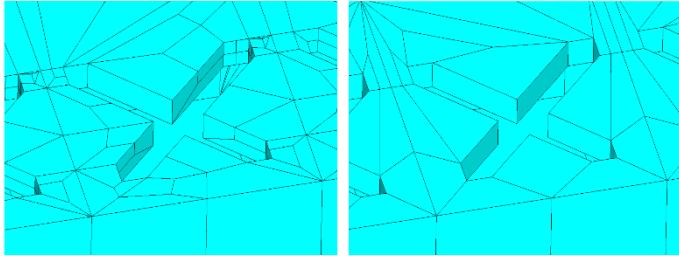


Fig. 4. Mesh of a slot in v2019 (left) and v2020 (right).

c) Acceleration of the meshing procedure

The meshing procedure is accelerated, especially the division of faces on narrow positions. This part is accelerated up to 10 times when compared to version 2019.

Other acceleration comes from the fact that pre meshing and addition of auxiliary parity segments are optimized as explained above, causing reduction in the number of mesh elements and significant reduction of meshing time.

3. Material Library and New Material Definitions

The Material Library is introduced in the 2020 version. Library is installed automatically with the rest of the software. It comes with 81 predefined dielectric materials which are commonly used at microwave frequencies, covering a wide range of antenna applications, scatterers, passive or active microwave circuits, human tissues etc. Users can immediately select a material from the predefined database or expand the library by adding new materials through a simple procedure.

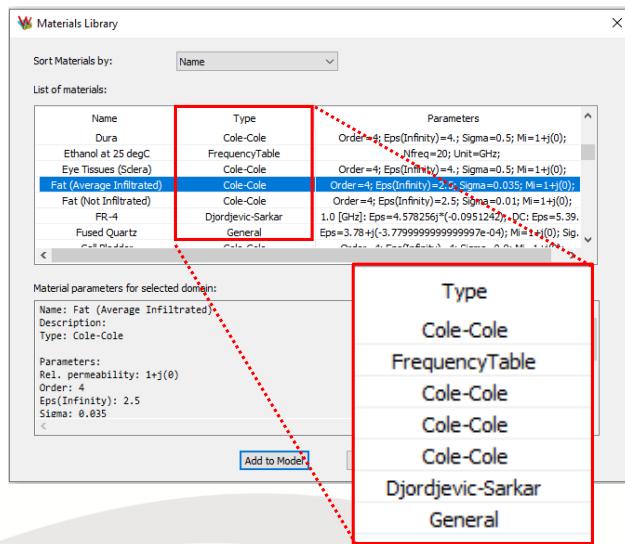


Fig. 5. Material Library dialog box/window.

The frequency dependency of the material parameters can be specified by filling in the Frequency tables, or entering the required parameters of the Cole-Cole or Djordjevic-Sarkar approximations. These are novel means of establishing the frequency dependent parameters introduced with the Material Library in addition to the previously available method where frequency dependency could be introduced using the freq() or freqtab(arg1, [arg2]) functions. The latter can still be used with materials described as "General".

4. New Selection Modes

In order to facilitate manipulations of a model, especially a very complex one, new selection modes are introduced.

The option "Select Connected Faces" performs automatic recognition and selection of all faces that are connected directly or indirectly with the given one.

By using the option "Select Bodies by Size", all bodies whose size is either smaller or larger than the given size are automatically selected. This can be quite useful when working with complex imported models as the selection of all small bodies can be performed in a single-click. For the cases where such small bodies are not relevant for EM simulation, the selected items can be conveniently deleted or set as unused.

5. Local Settings

In addition to previously available options used to set a distributed loading on the level of a face and a wire body, distributed loading can now be set on the level of a body of any type. This greatly simplifies setting the same distributed loading on the entire model, which is often required in practice as one metal material is used for manufacturing of all the metal parts.

Reference frequency can now be set on the level of body, face or edge of a wire body. The local settings of the reference frequency have no influence on mesh size, but only influences the order of current approximation, providing very simple and tight control of simulation accuracy.

6. Preview of the Model on Open

Opening a model in WIPL-D Pro CAD initiates a reconstruction process of successively executing all the commands from the command list. In the case when the command list is very long, the opening of the model takes some time. The time required to open a simple model is less than a second, but it can take much longer for very

complex models. Although not critical, such a long time can become an important issue when one is trying to locate a particular model passing consecutively through the opening procedure of many models until a correct one is found. To make the procedure of finding the right model simple and fast, in the new version the image of the model is saved together with the model files, each time a new model is created or the existing model modified. When browsing the projects in the Open window dialog box, the saved images are shown in the graphic preview window at the same time allowing fast and easy location of the correct model.

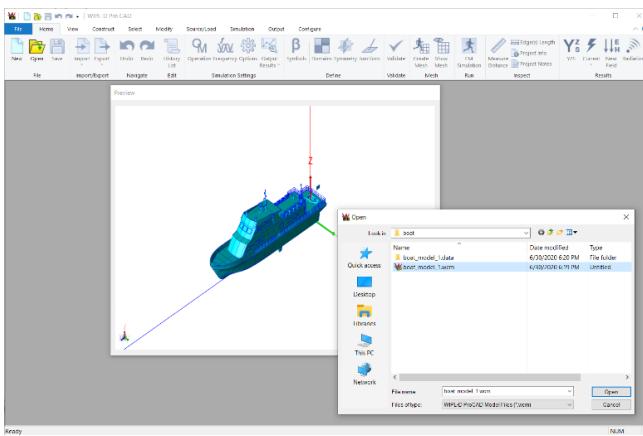


Fig. 6. Model Preview on Open.

7. Remote Run

With the Remote Run feature, the process of model creation and simulation can be divided and performed on two different machines. The modeling can be performed on a local Windows machine with limited computational capabilities, while computationally demanding simulations can be executed using a powerful remote server. The server can be a machine working under a Windows or a Linux operating system, or a GPU equipped cluster working under Linux.

The process of running a simulation on remote server is completely automated. One has to select a remote server and run the simulation, while upload of the model to the remote server and download of simulation results are done automatically. In addition to running basic simulations, Sweeper, Optimizer and Time Domain Solver projects are also supported.

8. Other Options/Improvements

a) AutoSave

The AutoSave option automatically saves and keeps project files in a separate folder, in order to enable recovery of the

last version of a project in case of an unexpected hardware or software shut-down. Since the time required for saving slightly increases with model complexity, one can turn off the AutoSave option or set a number of edits after which backup information is updated to a value other than the default.

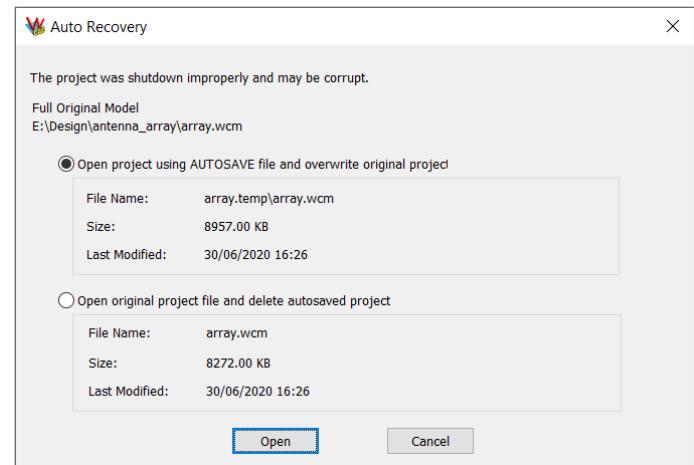


Fig. 7. Auto Recovery dialog box.

b) Automatic selection of laminar (open) loop in a fill hole operation

In the previous versions of WIPL-D Pro CAD a user had to explicitly call the option for selection of open (laminar) edges connected with the given one before using the Fill Hole operation. Starting with version 2020, selection of an open loop can be done automatically before the Fill Hole operation is performed. If one wants to keep the old practice, the option for automatic selection of an open loop should simply be de-checked in the Fill Hole dialog box.

c) Symbols Table is Non-Modal and Dockable

Symbols table is now non-modal, meaning that it can be open all the time and that one can simultaneously change symbols and observe the changes in the model. To make things more user-friendly, the symbols table can be docked similarly as the Project Tree, so current values of symbols can be visible at all times.

d) Setting radiation pattern and near-field by setting step per angle and length

In addition to specification of the radiation pattern and near-field calculation by setting the number of directions/points where the calculations are performed, it is now possible to do it by setting a step per angle and a step per length.