WIPL-D
electromagnetic modeling of composite metallic and dielectric structures

WIPL-D Pro CAD: What is New in v2022?

New features/improvements introduced in v2022 are:

1. **Assembly: The new instance at the top of topological hierarchy**
2. **Component library, comprising:**
   a. **Simulation-ready antennas**
   b. **Platforms**
3. **Improved import of CAD models:**
   a. **Renaming and merging of common symbols**
   b. **Merging of common domains**
4. **New naming algorithm – increased robustness when working with very complex models**
5. **Improvements in the meshing algorithm:**
   a. **Extraction of poles in the pre-meshing phase**
   b. **Improved mesh when working with complex models with a number of small faces and isolated vertices**
6. **Blending operation**
   a. **Rolling-ball and chamfers blend**
   b. **Propagating or non-propagating blend**
7. **Import of fully parametrized Ansys Nuhertz FilterSolutions filter models**
8. **New options for frequency dependent materials:**
   a. **Export to an .frN file**
   b. **Show numerical values of domain parameters**
9. **Other options/improvements:**
   a. **New functions in the symbolic mechanism**
   b. **Improvements in the Crop by Plane option when parts of a wire are placed in the cutting plane**
   c. **Characteristic Modes Analysis**
   d. **Setting of local mesh size and angular tolerances on the body level**
      …

1. Assembly: The new instance at the top of topological hierarchy

The new topological entity is introduced in the latest version of WIPL-D Pro CAD, in order to enable easier and more intuitive work with complex scenarios. The new entity is Assembly, and it is placed at the top of topological hierarchy.

An assembly is a collection of entities; an entity can be either a body or another assembly. The bodies contained in an assembly can be of any type. The assemblies, which are parts of another assembly, may themselves consist of bodies or other assemblies. Therefore, the assembly structure can be nested with assemblies contained one into another up to an arbitrary level. If only one level is present, i.e. all entities contained in an assembly are bodies, the assembly is a Level Assembly.

All manipulations that can be applied to bodies, like Translate, Rotate, Align with WCS and other, as well as Boolean operations can be applied to Assemblies as well.
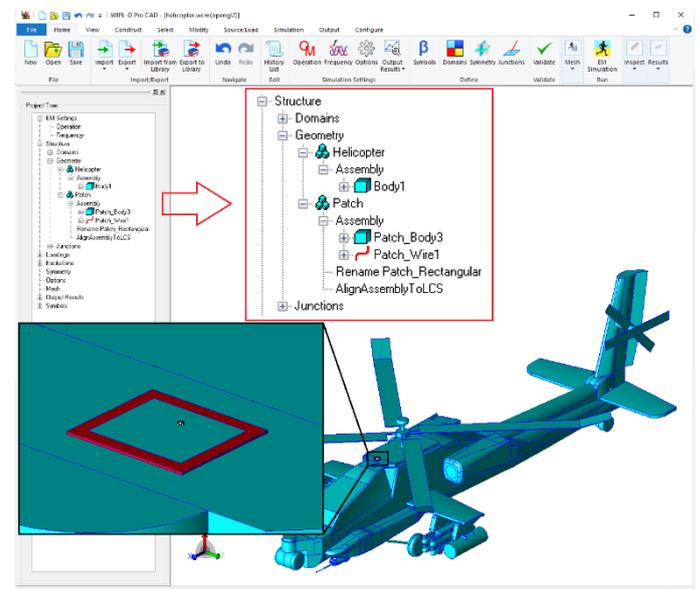

Fig. 1. Antenna placement scenario.

Therefore, the assembly enables creation of groups of mutually related model parts, and when performing an operation over the entire group, the group is treated as a single entity. For instance, an antenna which contains a few wire probes and a number of solid and sheet bodies can represent an assembly. Manipulations over the antenna, like creation of arrays, subsequent placing of the arrays to

an appropriate position in the model, etc. can then be performed in a very simple and intuitive manner.

2. Component Library

Starting from the new version, WIPL-D Pro CAD offers predefined libraries of:

- Simulation-ready antennas, and

- Platforms.

Import of a model from the library is performed through an intuitive dialog box. In the first step one selects the type of component to be imported - Antenna or Platform.

After a component is selected, a description of the component appears along with 4 illustrative images. For the predefined components those images are:

- In the case of an antenna: antenna preview, 3D and 2D radiation patterns and s-parameters in a certain range around the central frequency, as shown in Fig. 2.

- In the case of a platform: isometric view and three plane projections, as shown in Fig. 3.

When a platform is selected, the import to the project is performed in a single click. On the other hand, in the case of antennas, adjustable parameters should be set before the model is imported. For the predefined antennas the central frequency is always one of the adjustable parameters. For some antennas, like horns or reflectors, the user can also specify the desired gain in dB units in the main beam direction.

Regardless of its level of complexity, a component is always represented as an assembly after it is imported to a project. The name of the assembly corresponds to the name of the component. All symbols defining a component are imported with the prefix corresponding to the name of the component added to a symbol name. The parameters of any imported component can be changed at any moment by changing the numerical values associated with corresponding symbols.

a) Export to Component Library

The pre-defined component library can be expanded with user constructed models. An arbitrary number of symbols adjustable on import can be specified. This option dramatically increases modeling efficiency as frequently used components are just a few clicks away.
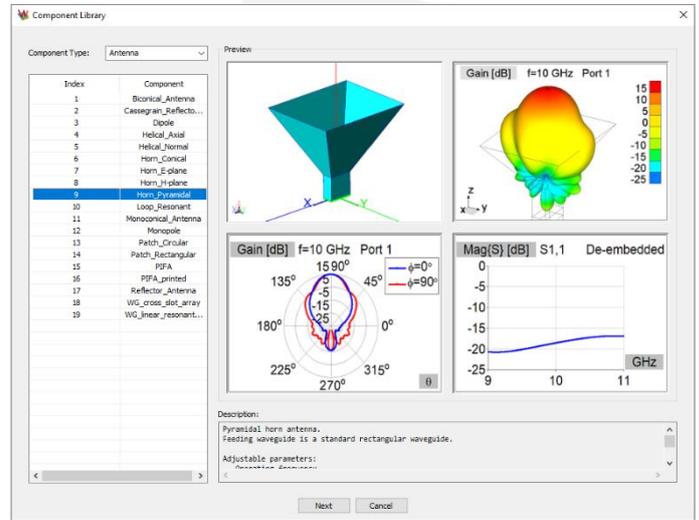

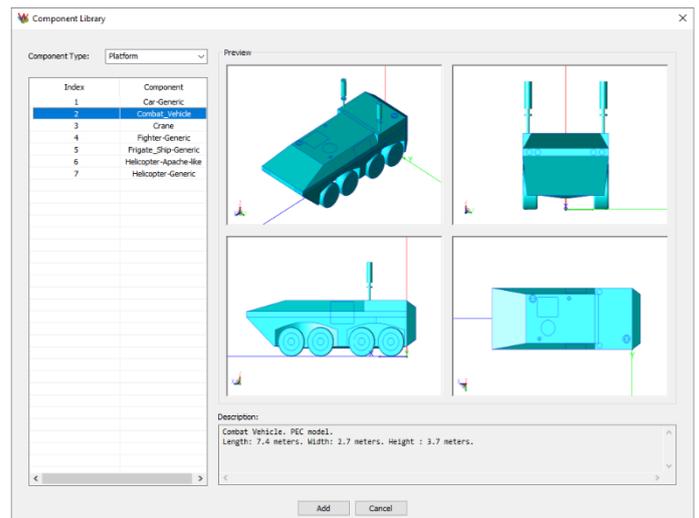**Fig. 2. Model of a pyramidal horn antenna in the Component Library.**

Fig. 3. Model of a combat vehicle in the Component Library.

3. Improved import of CAD models

In addition to the newly developed Component Library and corresponding mechanism for import of models from the library, the general mechanism for import of CAD models is itself significantly improved. The improvement is accomplished through introduction of two options:

- **Edit symbol on import.** All independent symbols from the imported model are listed on import, and their names and values can be changed. If a name of a symbol in the project being imported is set to be the same as a name of a symbol from the destination project, the two symbols are merged together.

- **Merge of domains.** If the option is checked, common domains from the destination and the project being imported will be merged together. Otherwise, for each domain from the project being imported a new domain will be added to the end of destination domains list.

4. New Naming Algorithm

A new algorithm for naming of topological entities whose level is lower than Body level, i.e. Regions, Faces, Edges and Vertices, is introduced. The new algorithm combines the following mechanisms in order to achieve high robustness:

- Parasolid Tracking data,

- Parasolid Attributes and special handling of their split and merge operations,

- Topological analysis based on name attributes of the closest neighbor, if the unique name of an entity cannot be determined by applying the previous two mechanisms.

Most of the customers will not see any difference when compared to the previous algorithm, as even the previous one was very robust. Nevertheless, in some cases there was space for ambiguity in the naming scheme, which is eliminated with the new algorithm.

5. Improvements in the Meshing algorithm

With each new version the meshing algorithm has been constantly improved. Improvements introduced in the latest version are related to increased robustness when working with complex models and better mesh in vicinity of geometry poles.

Detection and special treatment of poles are very important. In all previous versions of WIPL-D Pro CAD the pole itself would be converted to a high-valance vertex causing small angles at the vertex in all surrounding mesh elements, i.e. reduced Q-factor of the elements. With the new algorithm, geometry around the poles is treated as a special case, and meshed in such a manner as to prevent creation of high-valence vertices and elements of a low Q-factor.

The improvement is illustrated on a simple example of a mesh of a part of a spherical surface around the centrally placed pole, shown in Fig. 4. Angle tolerance is set to 30°. With the previous algorithm the number of mesh elements was equal to 24, with the average value of the Q-factor equal to 0.47. It is obvious that the most problematic elements are those around the pole, which are very close to non-convex, with a Q-factor of 0.026. When the new

algorithm is applied, the number of mesh elements is reduced to 20, along with a significant increase of the Q-factor. The mean value for the Q-factor is increased to 0.65, while the element with the minimal Q-factor has a Q-factor of 0.41.
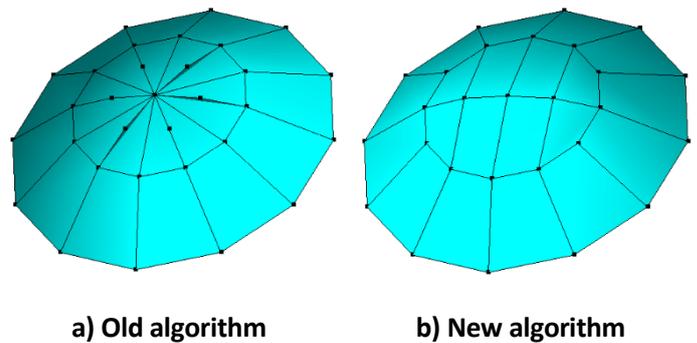

| a) Old algorithm | b) New algorithm |

Fig. 4. Meshing around a pole.

6. Blending Operation

Blending is smoothing of sharp edges in the model by introducing new faces, connected to the faces which contained the sharp edge. The option is introduced in the new version and it is very useful for creation of real-life models. For instance, starting from a model with sharp edges, a realistic model where sharp edges are replaced by blends that correspond to the radius of the milling tool is obtained in a few clicks.

Two types of blends are available:

- Rolling-ball blends, which are the blends of constant circular cross-section. The blend radius is specified by the user.

- Chamfer blends, which are the blends that have a linear cross-section. Dimensions of the chamfer cross-section are specified by the user.

By default, blending is performed on the selected set of edges. Additionally, an advanced option is available. Namely, one can specify creation of a propagating blend, where blending if performed not only over the selected edges, but also over all edges connected to them as far as the angle between tangents of the edges in the connection point is lower than a specified threshold. This option enables blending over a large parts of a model, where only a small number of edges is selected.

7. Import of Ansys Nuhertz FilterSolutions filter models

Import of fully parameterized models of distributed filters from TXT files is introduced in the new version. The filters should have been synthesized using Ansys Nuhertz FilterSolutions, and exported to the TXT format.

Microstrip, stripline and suspended microstrip technologies of distributed filter realization are supported. For microstrip filters feeders necessary to perform de-embedding are generated automatically with the geometry import and de-embedding is performed automatically. In the current version the user should create the feeders and execute the de-embedding procedure manually for other technologies.

The imported project is both, simulation and optimization ready as the geometry of a filter project is parameterized through symbolic variables and all of the necessary data are either transferred from original NuHertz .TXT file or generated automatically by the import routine (Fig.5). These include automatic setting of mesh size, reference frequency, edging, imaging, simulation frequency range, optimization goals and variables etc.
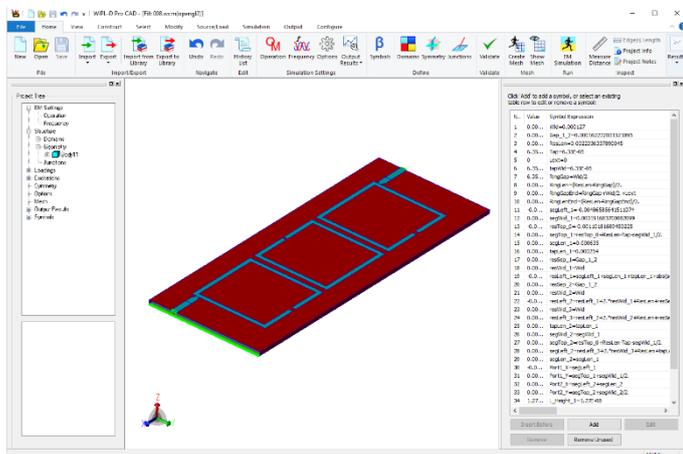

Fig. 5. Model of a microstrip filter after import to WIPL-D Pro CAD.

8. New Options for Frequency Dependent Materials

Two useful options related to materials, and especially useful for frequency dependent materials, are introduced in the new version. Using both options is very simple, and requires only a single click in the domains dialog box.

The first one is export of material parameters to an fr$N$ file, where N is an integer number. Domain parameters are exported for all frequency points for which the simulation

is specified. Each row in the file corresponds to one frequency point and contains the following data: frequency (in GHz), real part of relative permittivity, imaginary part of relative permittivity, real part of relative permeability, imaginary part of relative permeability, conductivity and mass density. The file can be directly used in WIPL-D models through the *freqtab* function. In addition, as the file is an ASCII file it can be easily used for additional post-processing.

The option for showing numerical values of material parameters is very useful when working with symbolically specified materials, as well as Cole-Cole or Djordjevic-Sarkar approximations, where values of permittivity and permeability are not directly specified, but defined through coefficients in corresponding approximate equations. Numerical values for relative permittivity, relative permeability, conductivity and mass density are shown for a frequency set by the user. The value of the frequency can be set to any value specified in the frequency settings of the model.

9. Other Options/Improvements

a) New functions in the symbolic mechanism

A number of new functions are introduced to the symbolic mechanism:

- double **c0** () – the function has no input arguments, and returns the speed of an EM wave in free space.

- double **eps0** () - the function has no input arguments, and returns the permittivity of free space.

- double **mu0** () - the function has no input arguments, and returns the permeability of free space.

- double **a_rect** (double) – the function returns the width of the standard rectangular waveguide in millimeters, for the frequency in GHz, passed as an input argument.

- double **b_rect** (double) – the function returns the height of the standard rectangular waveguide in millimeters, for the frequency in GHz, passed as an input argument.

- double **r_circ** (double) – the function returns the radius of the standard circular waveguide in millimeters, for the frequency in GHz, passed as an input argument.

- double **atan2** (double y, double x) – the function returns the value of the principal arc tangent of y/x, in the interval of [-π,+π] in radians.

- double **sqrt** (double) – the function returns the square root of the input argument.

b) Improvements in the Crop by Plane option

The crop by plane option is improved, so all attributes like generators, concentrated loadings, wire radii, etc. are maintained on the edges of the wires whose parts are deleted in the operation.

c) Characteristic Modes Analysis

Characteristic Modes Analysis is supported in WIPL-D Pro CAD starting from the new version. Both, running of a simulation and plotting results are fully supported.

d) Mesh settings on Body level

In addition to previously available options used to set local mesh size, edge and surface angle tolerances on the level of face and edge, those settings can now be set on the level of a body of any type. This greatly simplifies setting the same local mesh settings on the entire body, but also enables specifying local mesh settings on bodies whose number of faces and edges varies during a sweep or an optimization process.