



Comprehensive
Electromagnetic
Solutions

FEKO



QUARTERLY: September 2006

FEKO Suite 5.2 release

The latest evolution of the FEKO suite offers some exciting new technology to customers. This quarterly is dedicated to introducing some of those features.

The extension of CADFEKO in Suite 5.2, to include model control, will probably be the hottest new feature for most users. There are also several features that have been added 'under the hood' of the latest release, and this quarterly aims to inform users about some of these features. A complete description of all the new features can be found in the release notes that are shipped with FEKO.

The first article explains how existing users should approach CADFEKO for solution control. The second article explains how the new mesh refinement feature in CADFEKO can be used to obtain better meshes and therefore better results. Then, a short article on some of the less visible kernel enhancements, and lastly an article introducing a new excitation in FEKO.

As always, your comments on the quarterly are welcomed. If you would like to contribute an article, please send it to quarterly@emss.co.za.

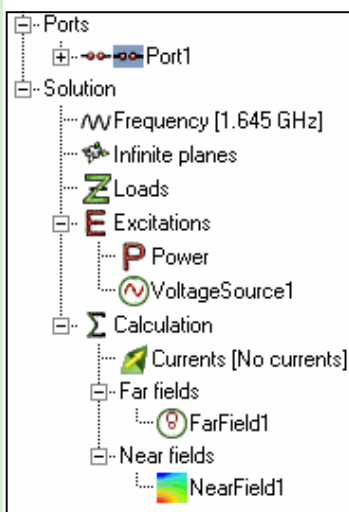
Solution control in CADFEKO—what existing users need to know

The solution control (everything after the EG card and quite a bit before it) is now done using a GUI interface—CADFEKO. This article explains to existing users how to use the solution control from CADFEKO and how this extension impacts existing models.

The question that is inevitably at the top of your mind is: "How will these extensions affect my existing models?" As with all FEKO updates, the answer is a resounding 'nothing'. All of your existing models will work as is with Suite 5.2. We do however recommend that all models that you create in future use CADFEKO for the control section setup as far as possible.

To familiarise yourself with the new usage model, it is recommended that you work through, at least, examples 2, 3 and 4 of the *Getting Started* manual. In these examples, two new branches are introduced into the contents tree—the *Ports* branch and the *Solution* branch. These branches of the tree contain all the solution items. Loads and excitations that are placed on geometry items (like edges or wires) are now positioned using Ports. Other solution entities can be added by right clicking on the appropriate item in the tree—for instance, to add an S-parameter calculation, right click on *Calculation* and select *Request S-parameters*.

Not all solution settings are available yet in CADFEKO. For instance, CADFEKO currently does not support electric/magnetic symmetry—if you want to use this, you will still have to use EDITFEKO. See the fourth getting started example for a better idea on how to do this.



Some tips:

- Set the measurement units for your model by selecting *Model unit* from the *Model* menu.
- If you have to edit the *.pre file, it is easiest to let CADFEKO create the basic file, and then edit it afterwards.
- If you do edit a *.pre file, the next time you run CADFEKO it will ask you if CADFEKO should keep the modified file you have on disk, or write a new file.
- A new *.pre file can be obtained from CADFEKO at any time by selecting the *Enable solution parameters* option from the *Solution* menu. (The existing edited file is automatically backed up.)
- Checking of the model (excitation positions, requested field points, etc) should now be done in CADFEKO.

Mesh refinement for better results

Creating a mesh from a given geometry is done in CADFEKO. A new tool to create a mesh from an existing mesh is available from Suite 5.2. This process is known as re-meshing. Re-meshing can be used to improve the quality of a mesh and to refine or coarsen a mesh. This is particularly useful when the original mesh has not been designed with electromagnetic analysis in mind. The re-mesh tool is activated by selecting a mesh element label, and selecting the *Refine/coarsen mesh* option in the *Mesh* menu of CADFEKO.

Improving Mesh Quality

It happens that the only CAD information that is available is 'dirty'. Figure 1 shows an imported geometry with a number of high aspect ratio triangular faces highlighted in yellow. This is typical of geometry derived from a model discretised for visualisation purposes, typical of STL files.

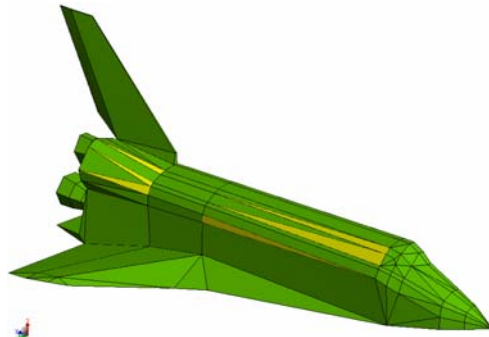


Figure 1: Imported geometry derived from an STL mesh

Meshing such faces will result in a significant number of distorted (high aspect ratio) triangles. These triangles can reduce the quality of results obtained from FEKO. Figure 2 shows the distorted triangles highlighted in yellow. The quality of the mesh shown in Figure 2 can be improved by re-meshing.



Figure 2: Distorted elements if geometry is meshed

When re-meshing, all elements on the same label are used as the seed mesh for the new mesh. To retain certain geometric features after the re-mesh, it is recommended to have a single label on either side of the feature, so that they are re-meshed separately. This ensures that the boundary between the labels is retained after re-meshing.

“Re-meshing can be used to improve the quality of a mesh and to refine or coarsen a mesh.”

“Distorted (high aspect ratio) triangles can reduce the quality of results obtained from FEKO.”

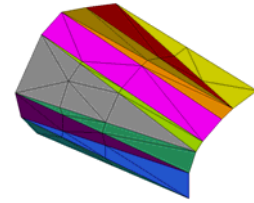


Figure 3a: Original label boundaries

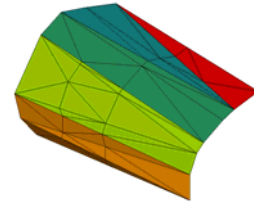


Figure 3b: Merged label boundaries

Figure 3 shows an example where mesh labels are merged to form more regular shaped boundaries. (To merge labels, select all the mesh elements that should be on the same label, right click and select *Rename*.) The regions are chosen such that the curvature will be retained after re-meshing, with the long edges between labels retained. Figure 4 shows the improved mesh after merging selected labels and re-meshing the complete mesh part. This model is likely to result in better solutions from FEKO than the mesh shown in Figure 2.



Figure 4: Resultant mesh after renaming labels and refining.

Mesh Refining / Coarsening

It is also possible to only re-mesh selected labels (elements). Meshes on adjacent labels will automatically have a gradual refinement to ensure proper mesh connectivity on the boundary. Figure 5 shows an example where selected labels are refined. The mesh elements highlighted in yellow are refined. Note that the adjacent triangles are also adjusted to match the new mesh size across the label boundary.

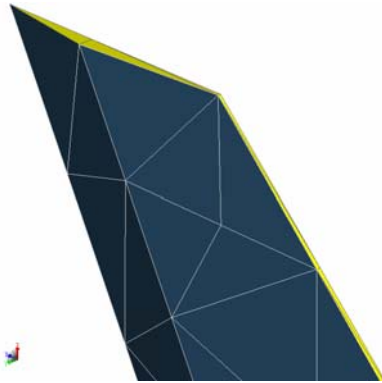


Figure 5a: Original mesh

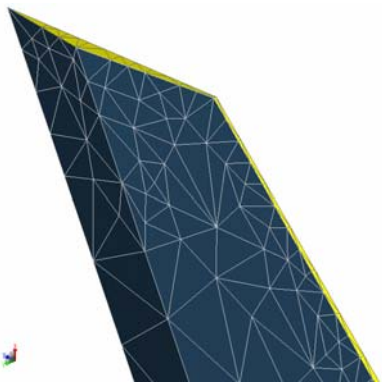


Figure 5b: Mesh after refining elements shown in yellow

CADFEKO can import various mesh formats, like NASTRAN, PATRAN, ABAQUS and others. The mesh size of an imported mesh may not be suitable for the frequency range of interest. Figure 6 shows an example where the original mesh is coarsened for efficient analysis at a lower frequency.

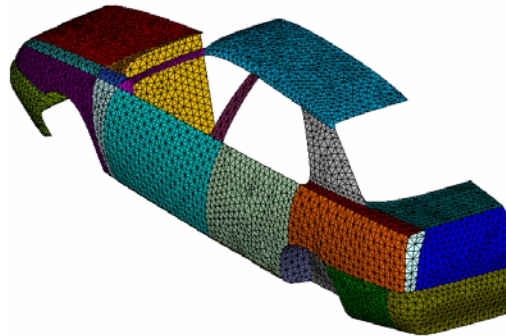


Figure 6a: Original mesh

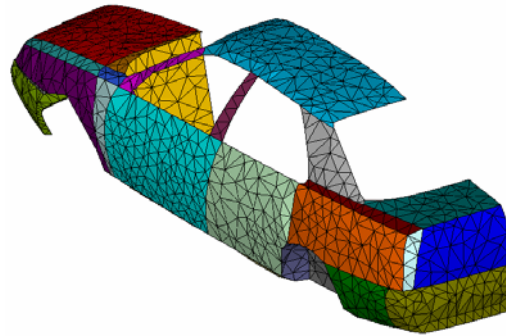
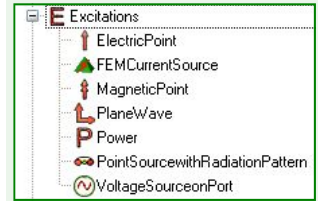


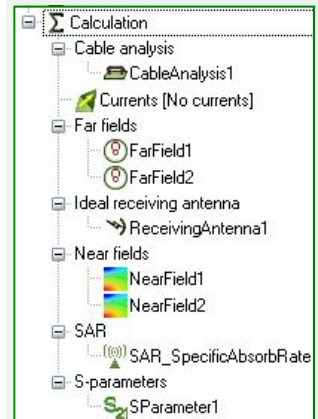
Figure 6b: Coarsened mesh

To preserve geometric features it is recommended to divide the model into multiple labels before coarsening the mesh. If the ratio of the required mesh size to the original mesh size is larger than 2, it is recommended to do the mesh coarsening in multiple steps.

Currently the re-meshing of triangles and tetrahedra is supported. For further information on how to check mesh properties and use re-meshing see the sub-sections “Mesh validation and Editing and “Refining meshes” in the *FEKO User’s Manual*.



Excitation options in CADFEKO

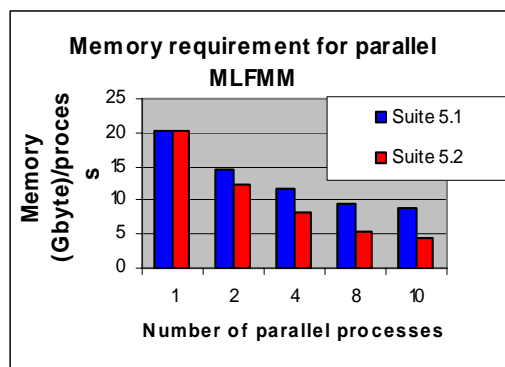


Output parameter specification in CADFEKO.

Some of the less visible new features

Every FEKO release comes packed with increased efficiencies, platform optimisations and more flexibility—Suite 5.2 is no different.

The memory parallelisation efficiency of the MLFMM has been significantly improved from Suite 5.2. This has been done by optimising the information that needs to be stored at each node. The benefit of this saving increases as more processes are used.

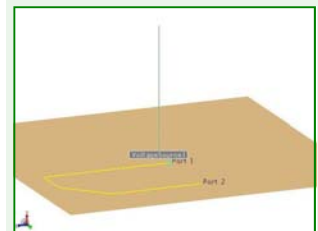


Calculation performance has also been improved on Intel, AMD and HP systems by using updated Math libraries for these platforms.

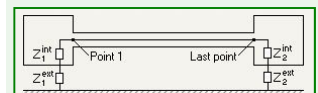
Multiple redundant floating licence servers are now also supported. When using floating licences and the floating licence server was unreachable (e.g. hardware failure) then FEKO could not be used and running FEKO jobs terminated. Now there is the option to setup multiple redundant floating licence servers. This means that, for instance three servers on three machines can be installed and then using FEKO floating licences works as long as at least a quorum, in this case two servers, is up and running.

Irradiation i.e. coupling into coaxial cables with a known transfer impedance can be done directly in FEKO.

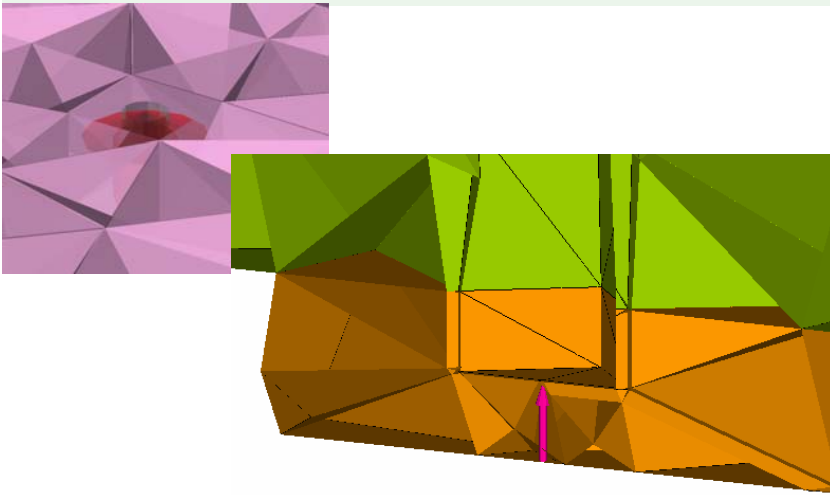
A combination of CableMod and FEKO is still required for the analysis (radiation and irradiation) of complex cable harnesses.



Coupling between an antenna, and a coaxial cable with two defined termination ports is done directly in FEKO.



Excitation in the FEM region



Prior to Suite 5.2, the Finite element method (FEM) region of a combined Method of Moments (MoM) and FEM model had to be excitation free—all excitations had to be defined in the MoM region. In Suite 5.2 this restriction has been lifted.

The new excitation can be included at an arbitrary position in the FEM mesh—there is no restriction as to how it should coincide with mesh elements. In general, it should be used such that the ends of the source coincide with a metallic surface, but this is also not required.

Included in the FEKO Suite 5.2 distribution is an example that uses this new excitation to feed a dielectric resonator antenna. The example can be found in the `examples\CAD_input` directory of your FEKO installation. It is named `DRA_finite`.

The radiating element is inside a half sphere of dielectric material. The dielectric material is modelled using the FEM. Prior to Suite 5.2, the source had to be placed in the MoM region, which is an error prone task. Now a gap is placed between the radiating element and the outer conductor of the feed coax, and a FEM excitation is placed between the two. Refer to the *FEKO User's Manual* and the *Examples Guide* for more information.

Exhibitions

FEKO will be exhibited at many conferences this quarter. Keep an eye on the website for a more complete list.

We invite all FEKO users to come to the exhibits to discuss any FEKO related issues!

5–7 Sept	EMC Europe—Barcelona, Spain
6–7 Sept	Antenna Systems 2006—Washington D.C., USA
10–15 Sept	European Microwave Week—Manchester, UK
19–21 Sept	Mediterranean Microwave Symposium 2006—Genova, Italy
19–20 Sept	Military Antenna Systems Conference 2006—

Comprehensive Electromagnetic Solutions

APPLICATIONS

- Antenna Design
- Antenna Placement
- EMC Analysis
- Scattering Analysis
- Biomedical
- Microwave Circuits

SOLUTION TECHNIQUES

- Method of Moments (MoM)
- Physical Optics (PO)
- Uniform Theory of Diffraction (UTD)
- True hybridisation of MoM/PO and MoM/UTD

- MoM with Surface and Volume Equivalence Principle for Multiple Dielectric Bodies

- Planar Green's Functions

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- Parallel Processing
- Out-of-Core Solving
- Multi-Level Fast Multipole Method (MLFMM)

MODEL IMPORT FORMATS

- Solid models (Parasolid, ACIS, CATIA, Pro-E, IGES, STEP, Unigraphics)
- Meshes (CADFEKO, FEMAP, NASTRAN, AutoCAD DXF, STL, PATRAN, ANSYS CDB, ABAQUS, ASCII data format)

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