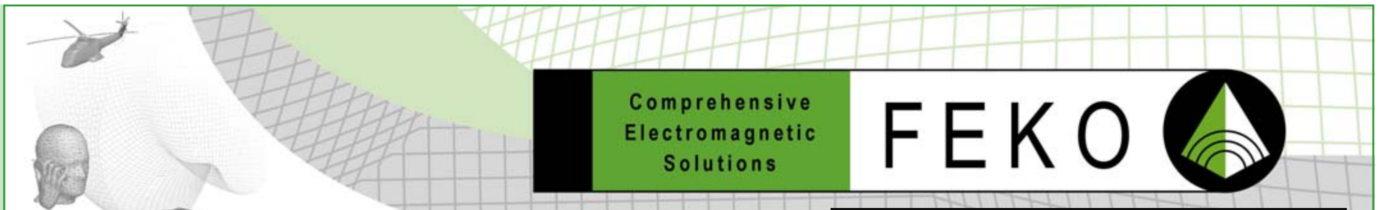

QUARTERLY: March 2007

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- Radiation hazard characterisation
- Newly appointed support engineers
- Model version control in CADFEKO
- Radio telescopes

Features in this issue

In this issue focus is placed on a case study describing how FEKO was used to perform an extensive radiation hazard investigation on a customer's implementation of the TETRA radio standard. The case study presents work done with FEKO encompassing problems in automotive and bio-electromagnetic engineering. As such it can contribute insight into the range of problems that can be analysed with FEKO's hybrid FEM-MoM formulation.

Two new application engineers are introduced who have joined the FEKO support team and a brief look is taken at CADFEKO's version control features for model development.

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*.

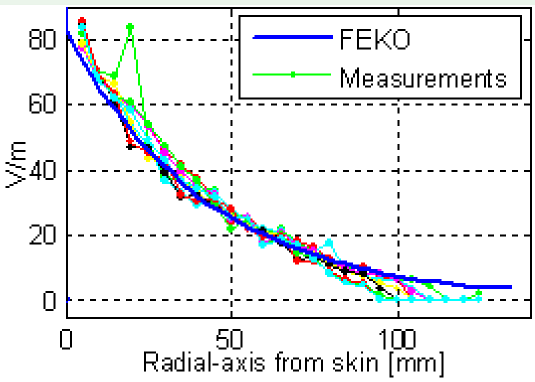
Application focus: Radiation hazard characterisation with FEKO

EMSS Consulting recently performed a radiation hazard investigation for a client implementing a TETRA radio network. The client wanted to establish whether TETRA radio equipment was safe in a range of specified user environments, including portable TETRA radios, phantoms with and without stab proof jackets, two cars and one motorcycle. The portable radios had to be evaluated in both belt-worn and shoulder-mounted positions and the vehicles were all equipped with vehicle mounted TETRA radios.

Model creation and validation

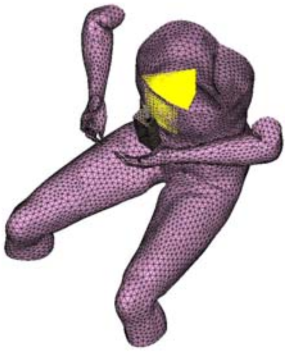
A large part of the project revolved around model preparation and testing. A basic handheld radio model was created with metallic elements in CADFEKO and simulated near-field values were compared with measurements made with a SPEAG DASY4 measurement system. The simulated and measured results were in excellent agreement, confirming that all pertinent features of the radio had been included in the model.

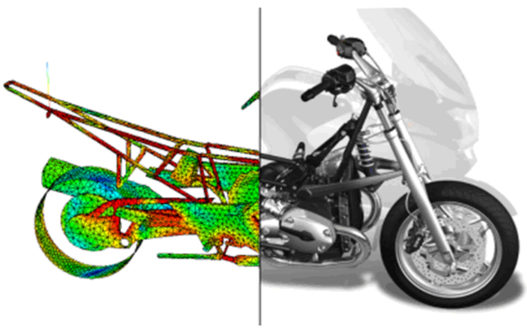
Phantom modelling and validation was a more complex process. The geometry of the phantom was supplied by the client and after manipulation and volume meshing in a third party software package the tetrahedral mesh was easily imported into FEKO. A single frequency was agreed upon for testing and tissue properties for the dielectric were



FEM phantom model validation

obtained from standards published by the FCC. Model validation was performed by placing a handheld radio in a belt-worn position next to the phantom and measuring the internal electric fields on a cylindrical axis system. The decay in field values from the phantom skin towards the centreline could then be compared with the corresponding simulation values. The simulated and measured values matched very well, proving that the tissue modelling assumptions were valid.

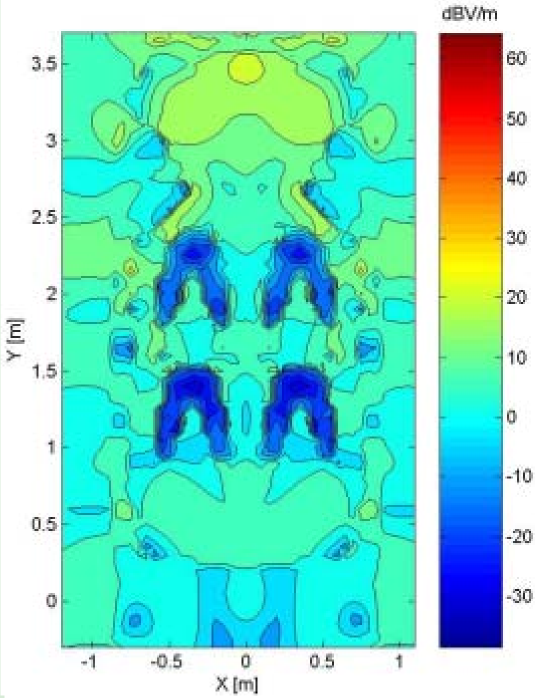




BMW motorcycle with simulated currents

Motor vehicles are complex structures and it is often difficult to determine which parts of a model are electromagnetically significant. The complexity of the models had to be minimised greatly to enable the consideration of MoM models of the vehicles with four FEM phantom passengers using only the available 32 GB of RAM. The resulting evaluation of accuracy for the vehicle models showed that the field magnitudes inside the vehicle matched measured values well, but the profile of

Application focus: Radiation hazard characterisation... continued



Field plane in vehicle at phantom waist height

"FEM and MoM regions are automatically detected without any input from the user. "

field lines across the centre of the vehicle did not match well. An important lesson from this exercise is that modelling a vehicle should never be regarded as a one-step task. It should ideally be an iterative process of modelling and measurement, where the models can be refined until they match the measurements as accurately as possible.

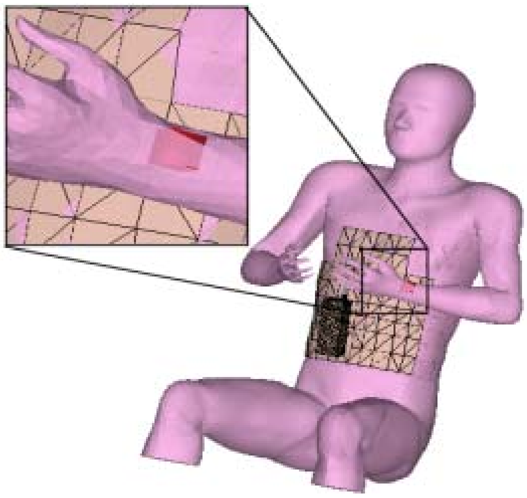
Simulation and analysis

The production simulations were concluded without unforeseen problems and an analysis of the results was done. All results were compared with the applicable ICNIRP standards for field values and SAR. The highest exposure levels were less than 30% of the maximum SAR exposure limits for public protection. The analysis resulted in some interesting facts, confirming intuitive predictions:

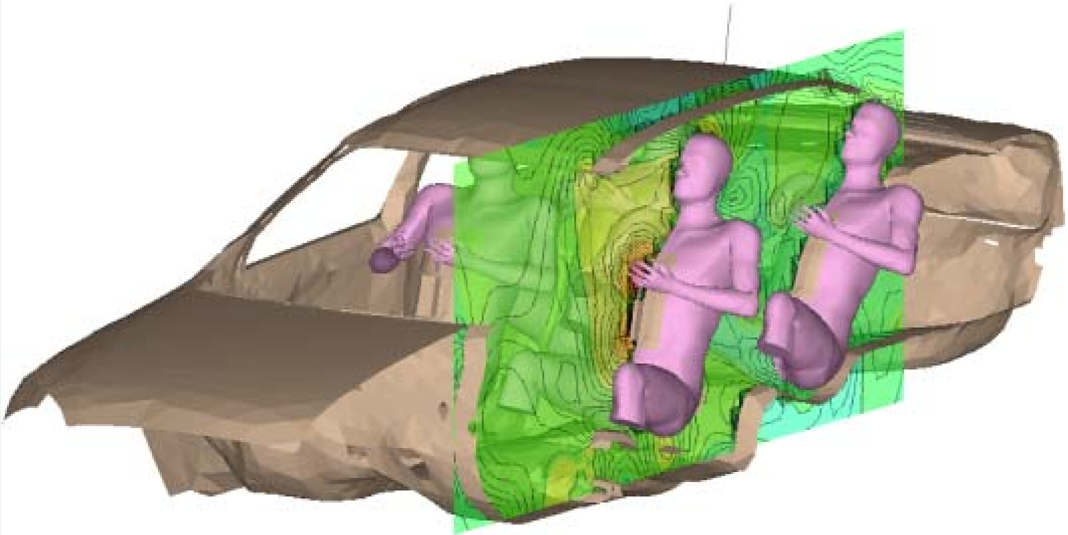
- A personal radio has no significant exposure effects on anyone except the user.
- Very little energy leaked into the cars from the outside vehicle-mounted radios, despite these radios transmitting significantly more power than the handheld radios.
- Stab proof jackets are a very effective form of isolation for users of personal radios. In the case of belt-worn radios the stab proof jacket deflected the energy away from the body of the phantom so that the new 10g cube peak SAR position was in the wrist of the phantom. The magnitude at this position was also significantly lower than the peak position in the body without the stab proof jacket.

Choosing FEKO for this project

FEKO made the modelling, simulation and reporting functions of this project easy to perform. FEKO's FEM-MoM hybridisation is ideally suited to the simulation of the complex mixture of dielectric and metallic structures in these problems. No special instructions or interim steps were required for a fully coupled solution. POSTFEKO's highly configurable visualisation features were used to render plots relative to ICNIRP standards with little effort and without third party post-processing tools, thereby presenting the client with easily comprehensible results.



10g cube peak SAR with stab proof jacket



Ford Mondeo with four phantoms wearing stab proof jackets and belt worn radio transmitting

Newly appointed application engineers

Maintaining customer support service of a high standard is of prime importance to FEKO. In the context of a rapidly growing customer base it is a pleasure to welcome two new application engineers to the FEKO support team.

Rohit Sammeta has B.S. degree in Electrical Engineering from the prestigious Indian Institute of Technology, Bombay (IIT-B). He attended the University of Mississippi (with an honours fellowship) working as a research assistant and towards his Masters until 2006. At the University of Mississippi, he worked on the design and analysis of integrated waveguides and also has experience in numerical methods in Electromagnetics.

Johan Huysamen

Rohit Sammeta

Johan Huysamen received the degree M.Sc.Eng. (Electronic Engineering with Computer Science subjects) from the University of Stellenbosch in 2007. In his postgraduate work Johan focused on electrically small antennas, investigating the theoretical limitations on the performance of small antennas and proposing an electrically small planar antenna for circular polarisation. Johan also followed postgraduate courses in antenna design, high frequency measurement and high frequency electronic design.

Both Rohit and Johan are employed in support of North American customers.

"Maintaining customer support service of a high standard is of prime importance to FEKO."

Version control in CADFEKO

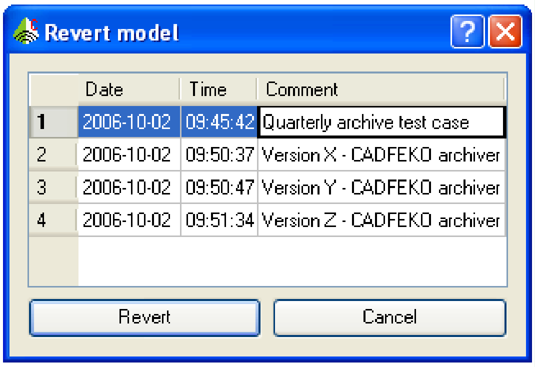
When designing complex models, it is sometimes required to backup a specific state of the model before continuing. CADFEKO can now store and retrieve different versions of the project files. The archiver is simple to use and has three functions: ADD, REVERT and REMOVE. When a model is added to the archive it is saved and copied to the *archive* directory. Referenced files, e.g. *.ffe, which can change independently to the CADFEKO model are not included in the archive.

Adding a model instance to the archive is simply initiated with the following menu item:

File -> Archive model

A dialog box will pop up prompting the user to input a comment for the new archive element. It is good practice to make this description a comprehensive one to distinguish between different revisions of your model in the revert or delete dialog boxes.

Reverting to a previous model version is done in the same way with the following menu sequence:



Reverting to a previous model version

File -> Revert from archive

The *revert model* dialog box will present the user with a list with date, time and comment for each archive instance to choose the correct version to revert to. This same information is presented to the user when an obsolete version is removed from the archive with the following menu sequence:

File -> Delete version from archive

"CADFEKO can now store and retrieve different versions of the project files."

Radio Telescopes

History of radio telescopes

The origins of radio telescopes can be traced back to Nicola Tesla who reported radio astronomical observations in the northern hemisphere during the summer of 1899. These early observations met with resistance in the scientific community and were only partially validated in 1996. The earliest modern investigations into extraterrestrial sources of radio waves were done by Karl Jansky in the early 1930's and were confirmed by Grote Reber in 1938 with a 9m parabolic radio telescope that he built in 1937. Since then radio astronomy has developed in various directions, all of which push technical boundaries in the design and development of radio telescopes.

Grote Reber's telescope, 1937

Exhibitions

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

26-30 March	PIERS 2007- Beijing, China
2-3 April	LAPC 2007- Loughborough , U.K.
3-8 June	IEEE MTT-S 2007– Hawaii, USA
10-15 June	IEEE APS 2007– Hawaii, USA

The Very Large Array at Socorro, New Mexico, USA

International collaborations

Radio telescopes are often used in multinational collaboration projects. A prime example of such a project is the Deep Space Network (DSN). The DSN is a collaboration between the Goldstone Complex in California, U.S.A., the Madrid Complex in Spain and the Canberra Complex in Australia. The DSN is used for communication with spacecraft, tracking the position of spacecraft, radio science experiments and other general science experiments. Examples of prominent work by the DSN is regular communication with the Voyager satellites and the Galileo probe. In the case of the Galileo probe data may be gathered by arraying the 70m antenna at the Goldstone Complex, a similar 70m antenna in Australia and two 34m antennas at the Canberra Complex.

The Square Kilometre Array and Karoo Array Telescopes

The Square Kilometre Array (SKA) is an ambitious multinational plan to construct an array of radio telescopes with a receiving area of 1million square metres! After preliminary investigations Australia and South Africa were identified as the preferred bidders to host the SKA. Although the winner will only be known in 2008, South Africa is building the Karoo Array Telescope (KAT) in the region where the core of the SKA could one day be located. The KAT will be an impressive radio telescope in its own right, although much smaller than the SKA. An interesting fact about the KAT is that the optimisation of the telescope feed structures was contracted to EMSS Antennas who are simulating these structures with FEKO, devoting significant amounts of RAM and processor time to this project. This once again shows that FEKO is a widely applicable simulation suite and can be used for large and small projects alike.