

# MAKING WAVES

**ANSYS HFSS helps to deliver innovative communications and networking solutions.**

By **Kate Moore**, Technology Centre Manager (Electromagnetics and RFICs), **Robin Granger**, Senior Consultant Engineer, and **Michael Jessup**, Consultant Engineer, Chemring Technology Solutions, Romsey, U.K.

**A**s industry finds more and wider uses for electronics, electrical engineers must take into account a broad range of factors when designing these smart products — from the environment in which they operate to interference with other electronics to highly original usage of consumer and commercial devices. In ensuring that operation meets and even exceeds expectations, Chemring Technology Solutions' engineers frequently face the challenge of understanding, diagnosing and pre-



**MODELING TOUCH SCREENS**  
[ansys.com/83screens](http://ansys.com/83screens)

dicting the behavior of electromagnetic waves as they propagate between antennas, printed circuit board (PCB) traces, packages and other parts of the system. Chemring leverages ANSYS HFSS to simulate the electromagnetic behavior of components and



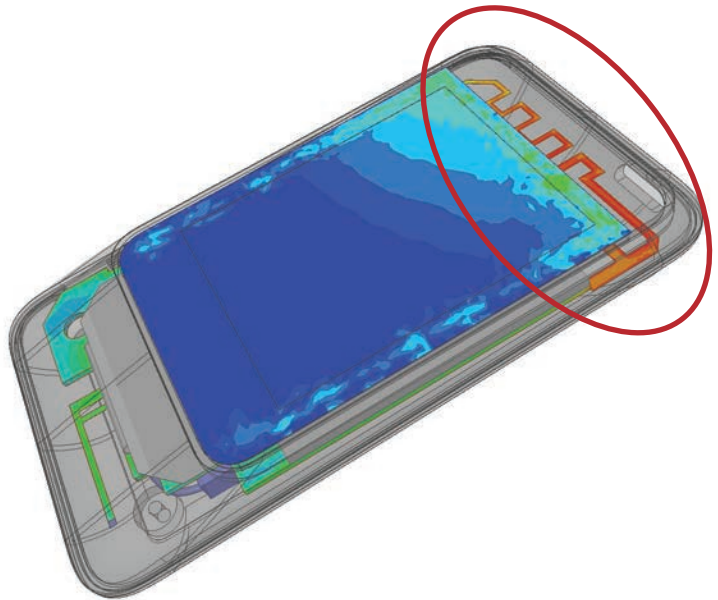
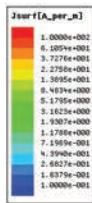
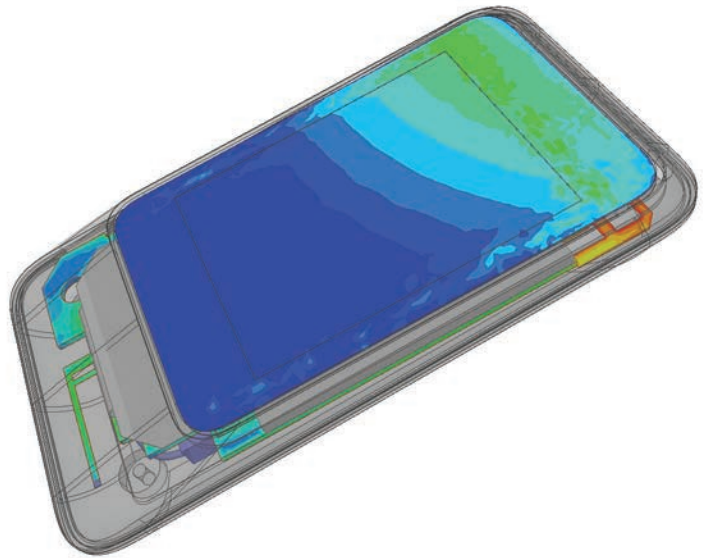
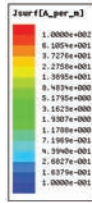
▲ SurfLink Mobile wireless hearing aid controller from Starkey Hearing Technologies

## Engineers must ensure that device operation meets and even exceeds expectations.

systems, making it possible to evaluate many more design alternatives compared to the build-and-test method. The end result is that the team is able to develop more innovative, robust designs in less time than would be possible using traditional procedures.

### HEARING AID CONTROLLER

At Chemring Technology Solutions, 400 engineers apply their technical knowledge to solve difficult problems in radar and wireless technologies, electronics and mobile communications, and software engineering across diverse markets, ranging from finance and transport to telecommunications and security. Chemring engineers recently assisted in the design of the SurfLink Mobile® wireless hearing aid controller from Starkey Hearing Technologies. The controller enables two-way stereo audio streaming between



▲ ANSYS HFSS simulation of controller with ITO coating covering full screen (top) predicts 24 percent to 29 percent efficiency. HFSS simulation of controller with upper 8.5 mm of ITO removed (bottom) predicts 66 percent to 70 percent.

a Bluetooth® device, such as a smartphone, and a wireless hearing aid. The greatest challenge was achieving a target of 50 percent radiation efficiency for the device's Bluetooth and 900 MHz radios, the result being that at least half the radio signal power produced by the device is transmitted into the airwaves. Engineers built a rough physical prototype using a 3-D printer, FR4 circuit board material and copper tape; they also simulated the design with ANSYS HFSS. The rough prototype measurements and simulation corresponded well, and predicted radiation efficiency of 80 percent at 900 MHz.

But when engineers built a true prototype using actual components, measurements showed efficiency of less than 25 percent.

The poor radiation efficiency was quickly traced to the touch screen sensor, which was absorbing approximately 4.5 dB. Engineers noticed that the indium tin oxide (ITO) coating on the touch screen physically extended to the top and bottom edges of the screen, rather than just on the active surface — a parameter that had been assumed in the HFSS model. Engineers made this change to the simulation model, and it showed a drop in efficiency to 25 percent (matching the



experimental value and verifying the accuracy of HFSS for this type of simulation). Engineers negotiated partial removal of the coating with the touch screen manufacturer to ensure reliable operation and product integrity. The prototype and updated simulation model showed efficiency of between 66 percent and 70 percent. The SurfLink Mobile wireless hearing aid controller went on sale in fall 2012 and has won numerous awards, including the CES (Consumer Electronics Show) Innovations 2013 Design and Engineering Award.

**BODY NETWORK**

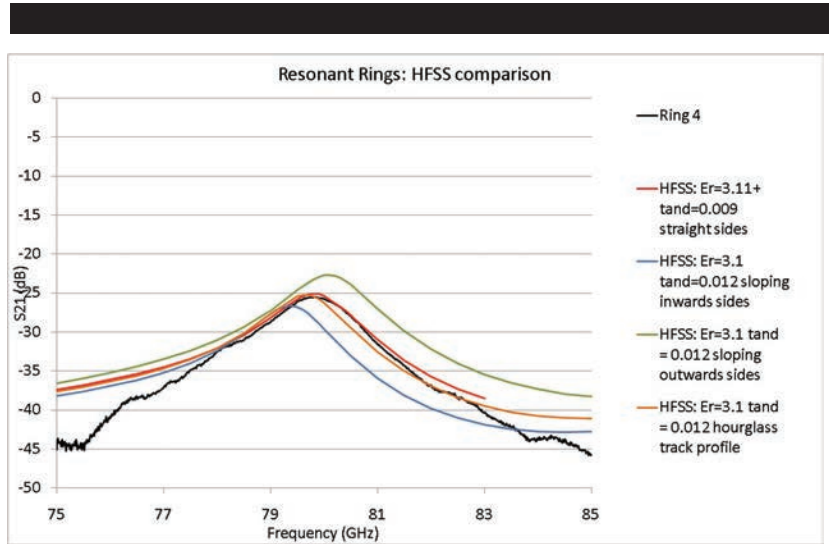
Chemring Technology Solutions' Gekko surface-wave technology is an alternative wireless solution enabling communication between devices over a surface. The signal doesn't travel through a wire; instead, it moves wirelessly over the surface of a fabric that incorporates a dielectric-coated conducting material that creates surface waves that deliver the wireless data. Surface-wave technology combines the reliability, security and performance of a wired system with the flexibility of a wireless system. Gekko overcomes one of the main issues with conventional body networking solutions: the signal's inability to propagate from the front of the body to the back, or around a limb, without the use of repeaters or reliance on reflections. Electromagnetic surface waves follow the propagation surface and provide a channel for secure and robust communications.

Building an effective solution required a solid understanding of surface-wave propagation. In particular, propagation around curved surfaces was not well understood. ANSYS HFSS was used to model surface-wave propagation around curved surfaces and to understand how surface impedance and wavelength can be varied to control the radiation from a particular bend. For example, the team evaluated around-torso propagation by creating a half-cylinder HFSS model with a diameter of 260 mm to approximate a female adult's torso. Wave ports were placed on the opposite sides of the cylinder and used as transmit and receive transducers.

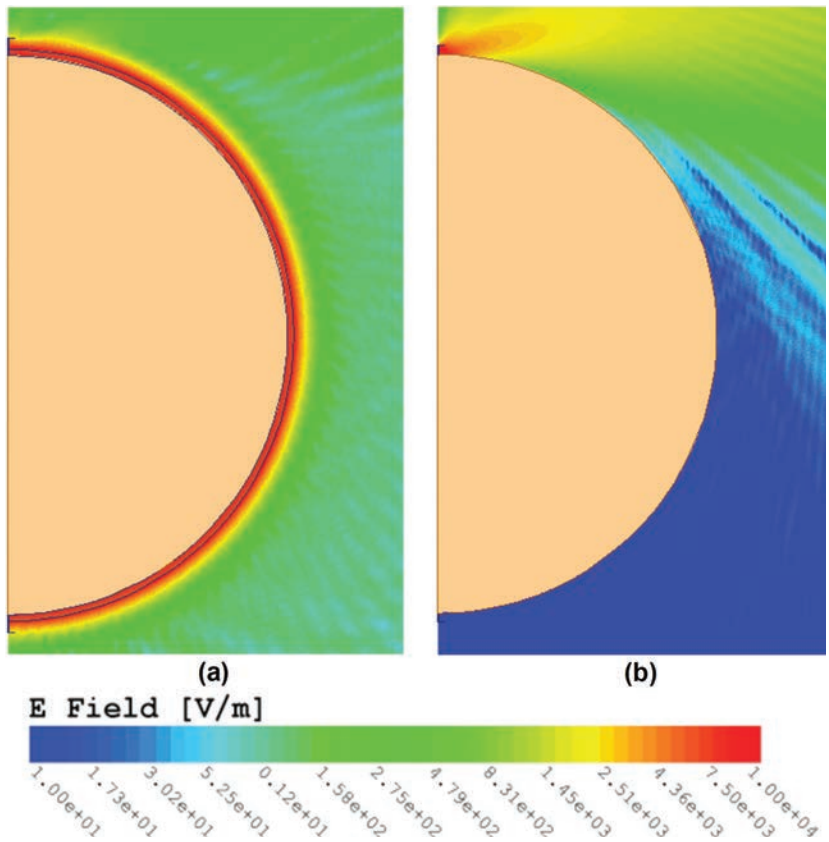
The simulation results showed that the surface wave propagates around the cylinder at 23 GHz and 60 GHz, while a

conventional radio signal cannot propagate around the body without use of repeaters. These simulations were used to construct a controlled environment to test the effect of and optimize design parameters

before going to the expense of building a prototype. The results also provided a very visual way to inform people of how surface waves work, which is much more effective than a prototype demonstration.



▲ Track shaping makes a significant difference in high-frequency performance.



▲ Simulation of complex magnitude of electromagnetic field over a cylinder representing (a) torso covered with surface-wave garment, and (b) bare skin torso. Losses are much higher in the bare skin torso.

## 77 GHz RADAR

Chemring engineers designing a radar system at the 77 GHz frequency used HFSS throughout the design process of the complete system, which included PCB, IC and antenna. When working

with lower frequencies, engineers typically use manufacturers' data sheets to provide important design information, such as the dielectric constant and the loss tangent. But data sheet measurements are usually made at much lower

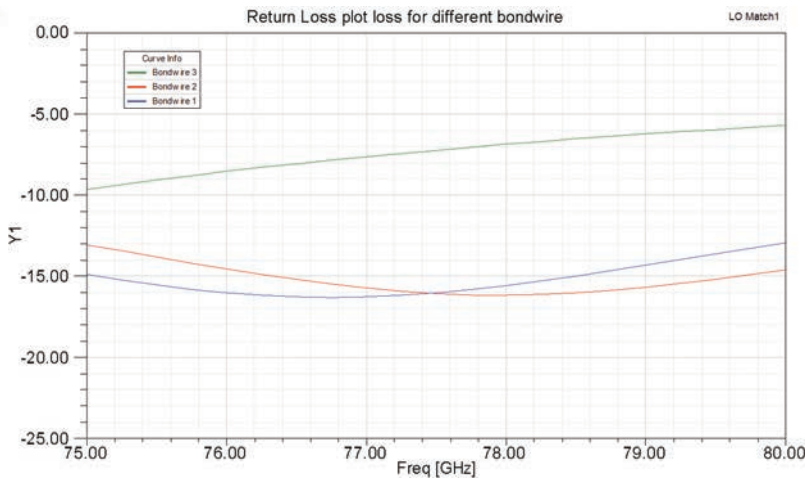
frequencies, so they are not accurate at 77 GHz. To confirm this, Chemring engineers built a simple prototype of the device and used HFSS to simulate it. As expected, the simulations did not match the prototype measurements because the material properties were not valid at 77 GHz.

So engineers adjusted the dielectric constant and loss tangent until the measured results overlaid the simulation at the peak. They had to consider that the as-manufactured traces differ from the perfect design geometry, and at these frequencies these differences have an impact. Engineers used HFSS to change the profile of the traces; this shaping improved the correlation between simulations and measurements. Next, they altered the generic bondwire models in HFSS to match the geometry of the actual bondwires. Again, they saw improvements in correlation. At this point, the HFSS model closely matched the performance of the prototype.

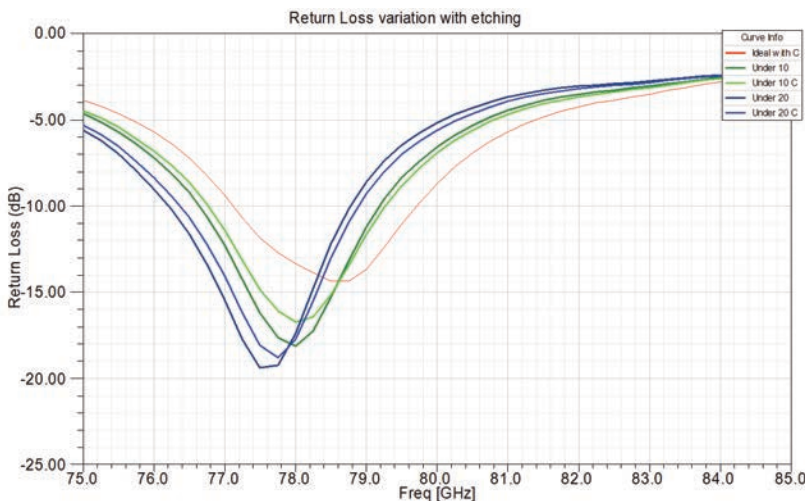
Chemring engineers used the HFSS model to evaluate alternative design approaches and optimize design parameters, such as antenna dimension trace geometry. They then used the model to analyze the effects of over- and under-etching to determine what manufacturing tolerances had to be achieved to ensure final product performance. The result was a substantial improvement in the performance of the finished product and a reduction in the time required to get the product to market.

At Chemring Technology Solutions, ANSYS HFSS plays a key role in most projects involving wireless communications, radar and high-frequency networking in which electromagnetic fields are critical. HFSS automatically generates an appropriate, efficient and accurate mesh for solving the problem. The end result is that Chemring engineers can evaluate as many alternatives as they want in the early stages of the design process. Once the design direction has been determined, Chemring engineers assess the design space to optimize key design parameters. Finally, they often evaluate the sensitivity of the design to manufacturing variation, which saves money in manufacturing and gets the design right the first time. ▲

**Engineers can evaluate as many alternatives as they want in the early stages of the design process, then assess the design space to optimize key design parameters.**



▲ HFSS predictions for identical circuit with different bondwires for radar system



▲ Parametric simulations show the effects of over- and under-etching, which helps to determine how much manufacturing variation can be tolerated.