Genelec DSP monitoring technology

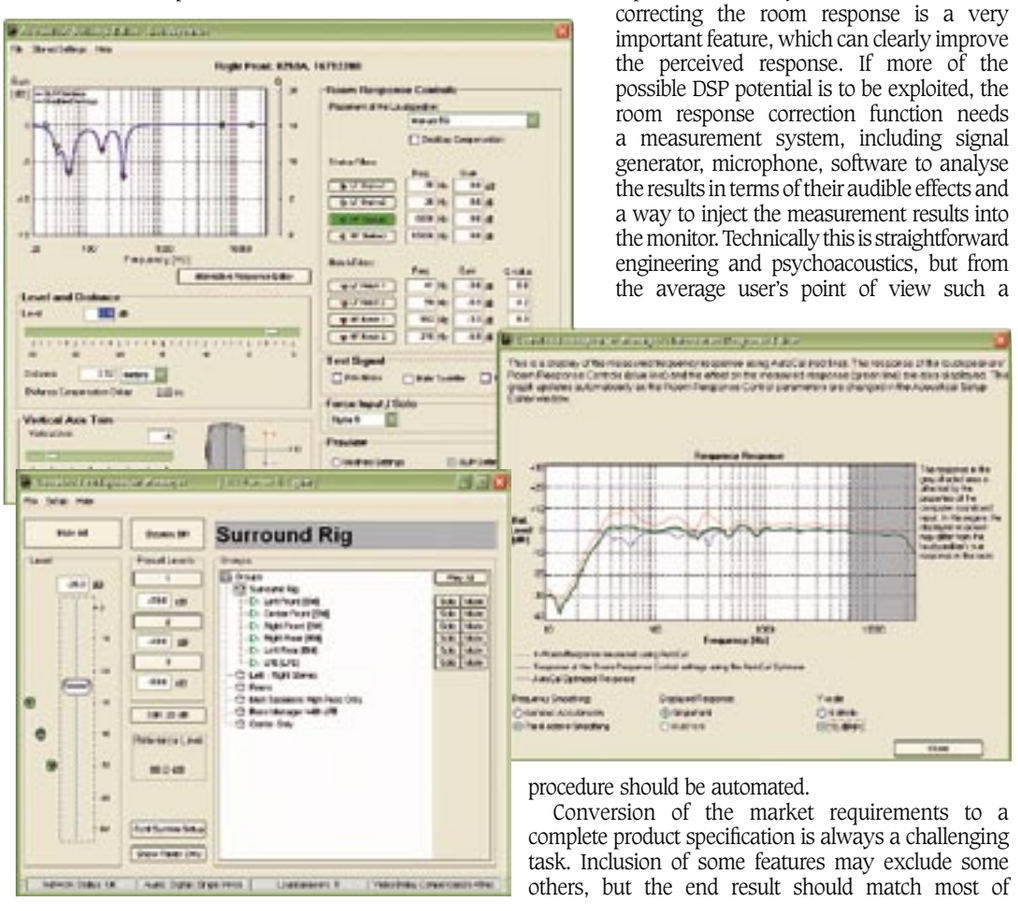
Integrating DSP into monitoring requires a number of key decisions to be made in the design and implementation stages if the technology is to offer real benefits to the user. Genelec's CHRISTOPHE ANET and ILPO MARTIKAINEN explain the company's take on the subject and how it has been applied to its new monitor products.

BACK IN THE 1970s the engineers who wrote the original Nordic Broadcast N12 specification for monitoring conditions in control rooms were very modern thinkers. One of the most advanced requirements was probably that the specification of the monitor's frequency response was defined, with acceptable tolerances, in the control room at the engineer's listening position.

This led to the question of how to guarantee meeting such specifications in varying room acoustic conditions. The solution was first to include calibrated rotary switches for frequency response adjustments in the monitors and these worked well and were later replaced by DIP switches. In the mid 1990s Genelec started to collect data from studios worldwide to observe and analyse what the real spectrum of room acoustic conditions was and how the products were set up. The results were somewhat surprising. The collected data was very useful in helping users to get the best out of their systems and to make their work as easy as possible. One result of the analysis is now included in the larger 8000 series monitors: the desktop compensation control that corrects the 160Hz boost caused by console-top loading when monitors are placed on the meter bridge. Another example is DIPtimiser software that works in conjunction with WinMLS measurement software. Based on the measured response, DIPtimiser calculates the optimum settings for the DIP switches on the back of Genelec monitors.

DSP crossover filters have existed for more than 15 years in sound reinforcement and the first active speaker systems with DSP crossovers appeared in the consumer world around that time. Typically the frequency response was ruler flat but perceived subjective performance was not as good as one would expect. At the same time, understanding of the criteria for excellent subjective performance was somewhat limited. Now it has become evident that excellent on-axis performance is not sufficient; the off-axis and power responses are also equally important. Equalisation of complicated errors is possible, but the problem of the listening area remains: optimising response at one point in space often means a less desirable response somewhere else. The old wisdom is true also here: it is better to prevent the errors from happening than correct them afterwards. Therefore the starting point should be pretty much as good as it can be.

So what are the benefits of using elaborate technologies? Steep crossover filters that can improve directional and off-axis performance are easy to construct with DSP. Equalisation of driver unit magnitude and phase responses is also straightforward but if the starting points are excellent the audible improvements may be small. However, correcting the room response is a very important feature, which can clearly improve the perceived response. If more of the possible DSP potential is to be exploited, the room response correction function needs a measurement system, including signal generator, microphone, software to analyse the results in terms of their audible effects and a way to inject the measurement results into the monitor. Technically this is straightforward engineering and psychoacoustics, but from the average user's point of view such a procedure should be automated.



Conversion of the market requirements to a complete product specification is always a challenging task. Inclusion of some features may exclude some others, but the end result should match most of

the real world needs. As said earlier, the starting point should be as good as possible. In our case the recently introduced 8000 series monitor design avoids all the common aberrations related to distortions, diffraction and uneven directivity, and hence it forms an ideal platform for using DSP in crossover filters and room response correction. Hardware and electro-acoustic design were thus quite ready for 8240A and 8250A, the DSP counterparts for 8040A and 8050A.

The change from stereo to multichannel productions in the analogue and digital production environment has caused major technology changes and has created new requirements for console manufacturers. However, it will take some time before the installed base of analogue and digital mixing consoles have extended multichannel monitor routing and the appropriate volume controls.

As the installed base of mixing consoles have different monitoring outputs, DSP loudspeaker systems need both analogue and digital inputs. There are many options for transmitting digital audio but to adhere to an industry standard, we chose AES-EBU. The obvious solution for the requirements of monitor grouping, global volume control and other similar functions, as well as automated room response correction is to connect all loudspeakers to a control network and have the software perform the necessary functions.

Many different audio control networks have been proposed, but none have gained unanimous popularity. Our industry has some way to go before it has the network standards that are common in many other industries (for example, CAN which is found in every modern car). We developed a bi-directional network using the physical layer of CAT5 cable, RJ45 connectors and related electronics with a proprietary network protocol. The user interface is called GLM, Genelec Loudspeaker Manager, and can control up to 30 loudspeakers. The GLM software runs on PC (soon on Mac too) and with it the user has global monitor volume control, user-definable preset levels, individual channel mute and solo functions, bass management bypass as well as system mute and dim commands.

The GLM software is designed with usability in mind. It is simple to use and has Cabling Wizards for setting up cables, channels, and basic system connections and an Acoustic Wizard for setting distances, room response controls and loudspeaker sensitivity level. The GLM software can be minimised on screen to have the basic controls visible. In addition to the graphical fader, the volume control can also be a hardware knob connected to a USB port.

However, all applications do not need full control of everything all the time and there are plenty of cases where it is actually better to limit user access. In these cases the system has two additional operational modes: Stand-Alone (stored settings) and Stand-Alone (manual) mode. Both can be used with analogue or digital sources. The 'stored settings' mode is very convenient in applications where the system needs to be properly set up and calibrated without the need for extra changes. After setting up the system with the help of the GLM wizards, the data is stored in each loudspeaker and the network can be shut down or disconnected. In this mode the console monitoring section (either analogue or digital) provides all monitoring options. The 'Manual' mode uses the well-known dip switch controls common to the 8000 series analogue products. In this respect the 8200 series products emulate the 8000 series and this can be useful in facilities that have analogue and digital rooms.

The 7000 series subwoofers were the starting point for the 7260A, 7270A and 7271A DSP subwoofers. They have full network control and an eight-channel AES-EBU bass management system. The 7200 series subwoofers can only be used with AES-EBU signals.

It is easy to identify that the most audible improvement potential of DSP based systems lies in automated room response correction. It is more rule than exception to read or hear comments of too much or too little bass and monitors are often blamed. Although the perception is true, in most cases there is no problem in the monitor itself. The reasons are either in the room or in the placement of the monitor in the room, or both. However, the magnitude of the aberrations a room or wrong placement can cause may exceed any reasonable correction capacity, and hence everything possible should be done to remove the root causes. As said in the beginning, it is better to prevent the errors from happening than to correct them afterwards. Also the microphone works in a different way to an ear, so the correction algorithms should be carefully considered.

The Genelec AutoCal is a fully automated acoustical calibration tool for a single room multi-loudspeaker system. This software was preceded by the DIPtimiser work mentioned earlier.

The AutoCal system produces loudspeaker-generated test signals recorded by a high quality calibration microphone to determine correct acoustical alignments for every loudspeaker and subwoofer on the GLM control network. AutoCal uses a sine tone sweep generated in each monitor and subwoofer. This sweep is recorded using the 8200A Calibration Microphone at one (SinglePoint) or more positions (MultiPoint). The frequency response for every monitor is calculated. AutoCal then determines the correct acoustical settings for flat frequency response at the listening position (or over an area), aligns for equal delay from all monitors to the primary listening position, and aligns output levels and subwoofer crossover phases.

AutoCal sets the four notch filters in the 7200 series subwoofers and four notch filters in the 8200 series monitors along with two high frequency and low frequency shelving filters. The automated calibration procedure aligns distances within 1.5cm and levels to within 1dB. A typical 5.1 system takes about five minutes to calibrate.

The technology in Genelec 8200/7200 DSP loudspeakers is not there to correct and fix mistakes in the electro-acoustic design but rather to offer improved usability and flexibility for often complicated and rapidly changing productions and to provide an efficient tool for integrating loudspeakers into the acoustics of the listening environment. The monitoring system should adapt to the working needs and situations as far as possible, not the other way around. Built on the solid acoustical foundation of the 8000 and 7000 series products, these new products are the logical step in the line of development to make the end user's work easier, more enjoyable and more productive. ■