EASE

Software Designed to Enhance Acoustics

By
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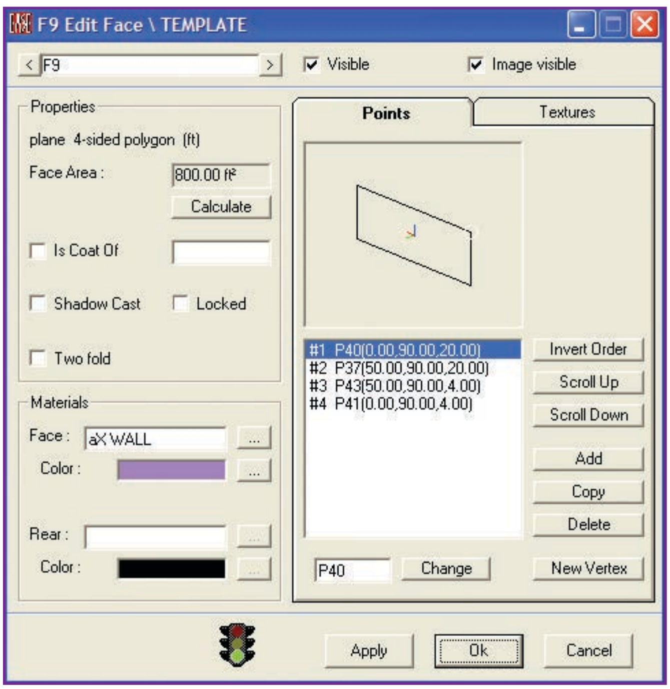
(United States)

Enhanced Acoustic Simulator for Engineers (EASE) is engineering design and analysis software for optimizing acoustics. The EASE software suite provides system designers and consultants with a set of tools for all aspects of professional practice, from detailed, realistic modeling and simulation of venue acoustics and sound system performance to professional data assessment and verification.

EASE's Evolution

Wolfgang Ahnert, the initial developer of Enhanced Acoustic Simulator for Engineers (EASE), studied technical acoustics at the Technical University Dresden and at the Moscow State University (Lomonossov). Beginning in 1975, he worked as a consultant planning theaters, concert halls, and other cultural buildings. He co-authored a book on architectural acoustics in 1980, and has published numerous books and papers (see Resources).

Photo 1: EASE provides this window for each face in the model.



In 1990, Ahnert founded the Engineering Office Acoustic Design Ahnert (ADA). Since receiving his PhD, Ahnert has been a professor at the Hochschule für Film und Fernsehen (Academy for Film and Television) in Potsdam-Babelsberg, Germany. That same year, ADA released EASE's first version, a full graphic MS-DOS-based CAD program for acoustical analysis. EASE V. 2 was released in 1993. In 1999, EASE V. 3.0, the first version designed for Windows 95/NT/ME/2000 was released by Ahnert, Stefan Feistel, and Rainer Feistel.

From 1998 to 2001, another important analysis program, CAESAR, was developed by Michael Vorländer and Andreas Schmitz of Aachen University in Germany. CAESAR used ray tracing to predict acoustical parameters. It used ray tracing and image methods for auralization and incorporated scattering in the analysis.

At this time, EASE provided electroacoustical prediction and boasted a large and growing loudspeaker database provided by manufacturers, a directivity Direct Link Library (DLL), 3-D visualization, real-time auralization, and professional support for users. In 2001, EASE became available with an Analysis Utility for Room Acoustics (AURA), which incorporated the CAESAR algorithms.

EASE is now produced by AFMG Technologies GmbH and is available in two different versions: EASE Standard and EASE Jr. The software suite is also available with three auxiliary packages: AURA (advanced

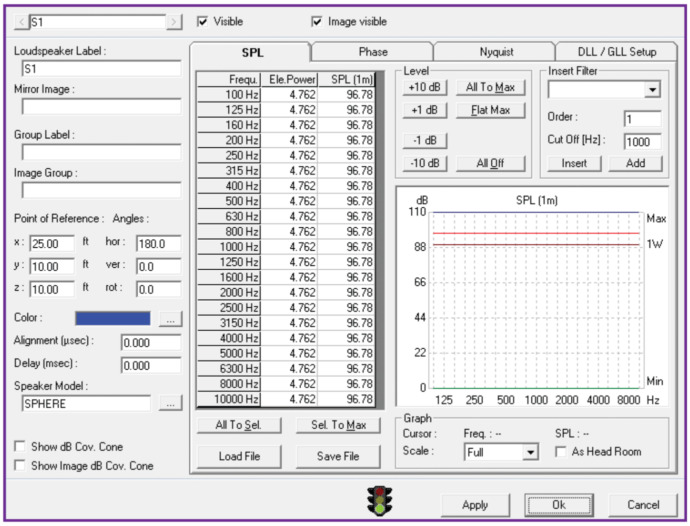


Photo 2: Even though the loudspeaker model supplies directivity and frequency-response information, the user can set the loudspeaker's aim, delay, and electrical power input.

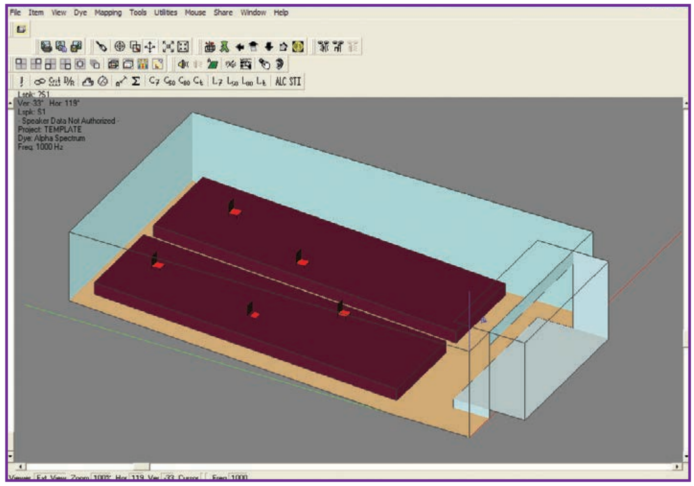


Photo 3: Standard rendering adds realism to the model.

calculation capabilities), EARS (advanced auralization capabilities), and infrared (for infrared hearing assistance system design). See Resources for more information about the three options. EASE, which is shipping in V. 4.4, uses hybrid ray-tracing routines to balance accuracy and computational efficiency.

Operating EASE

When opening EASE, the first screen users see is the EASE desktop. From this screen, users can set up a new project or open an existing one. Once a project is opened, the screen changes to the project desktop. The project desktop screen links to folders that are specific to certain projects.

EASE users can input models via the built-in 3-D CAD modeling interface, which enables users to position vertices, create lines by connecting vertices, create faces (planes) by connecting vertices or by extruding lines, and create 3-D structures by extruding faces. In creating models, materials can be selected from the more than 700 material properties files supplied with EASE or by acoustical material manufacturers. Users can edit or design their own material files containing absorption and scattering coefficients at one-third-octave resolution. For simplicity in adding windows, doors, wall-mounted video displays, and so forth, faces can be "coated" onto other faces, creating areas within it that have different material properties than the main part. For example, we can create a face that represents a wall, then coat a window face onto that wall. The window face area of the wall can have the acoustical properties of glass while the rest of the wall has gypsum wallboard properties.

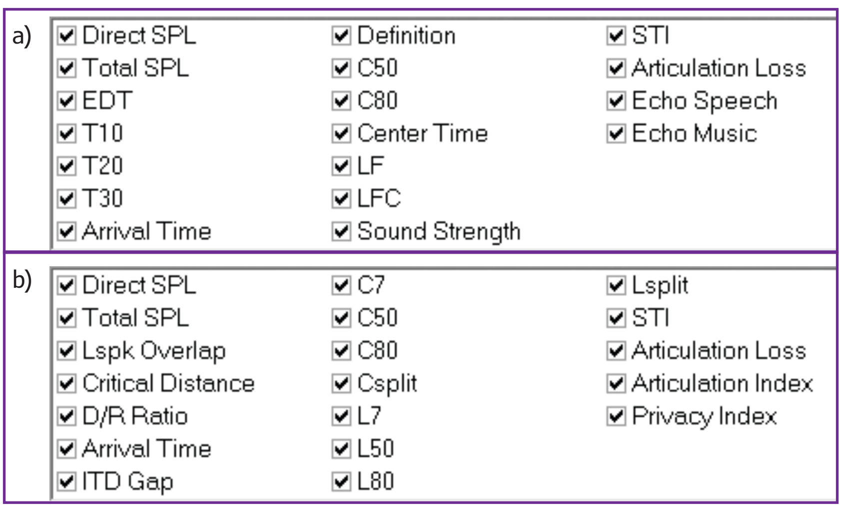
Alternatively, models can be imported and exported from/to .dxf or SketchUp files. When the user is preparing a model for analysis, EASE verifies that all faces are correctly defined and are oriented with the active side facing the inside of the model. After a model has been created, it often needs to be adjusted. A "check holes" dialog box provides automated checking and correcting tools to remedy errors.

The EASE 3-D CAD interface enables users to design a wire frame model. When adjusting the model, it is helpful to look at the properties of specific faces. This can be done by clicking on the face and right-clicking Properties (see **Photo 1**). The right-hand panel lists the vertices that define the face, along with their X, Y, and Z coordinates. The "Two fold" check box enables the user to create faces that are active on both sides (e.g., a balcony) rather than having one side facing the world outside the model, as for outside walls, ceilings, and so forth.

Various items (e.g., vertices, faces, sources, listener seats, audience areas) can be grouped together as objects, which can then be moved, duplicated, or rotated as a single unit.

Loudspeaker data in the EASE format is available from most professional loudspeaker manufacturers. Available sound source data includes male or female humans, simple loudspeakers, multi-way loudspeakers,

Photo 4: AURA Mapping (a) or Standard Mapping (b) can be used to plot and map these parameters after completing the necessary calculations.



simple columns, line arrays, digitally steerable columns, horns, clusters, and alarm systems. The included SpeakerLab creation module enables users to build their own source models. **Photo 2** shows the parameters that a user can specify for a sound source, in this case, using a simple spherical source as an example.

Once the model has been built, the user can click on "Room Data" under the "Edit" menu and see such information as room volume, effective surface area, mean free path length and time, average absorption, and reverberation time (RT) calculated by either the Eyring or the Sabine method. This information is useful in making initial decisions about the amount of absorption to place in a room.

Optimizing RT

EASE includes a method to optimize RT to pre-established goals. This intuitive tool helps save valuable time, avoiding the need to experiment with different wall materials on different surfaces to adapt the model to real-life requirements. The user can also insert real-life measured RTs into EASE or to use advanced methods available for RT calculations.

EASE can use either standard or architectural rendering to portray the model. The latter enables

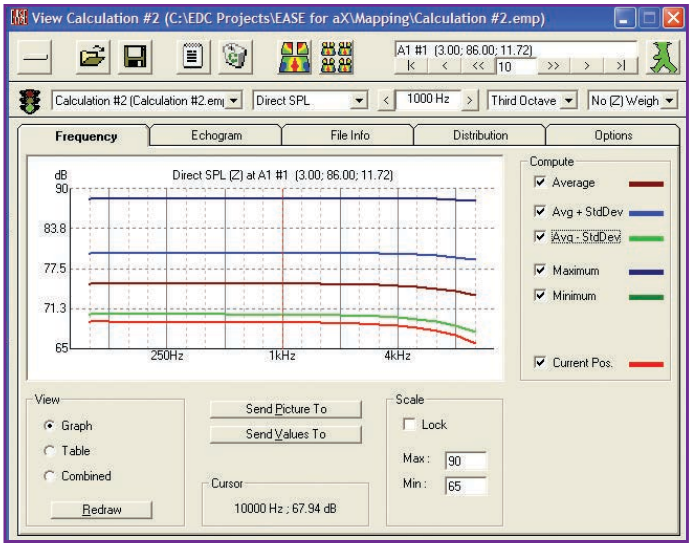


Photo 5: Plotted parameter values can be shown for a selected position in an audience area, or as a maximum or minimum, with or without standard deviation included.

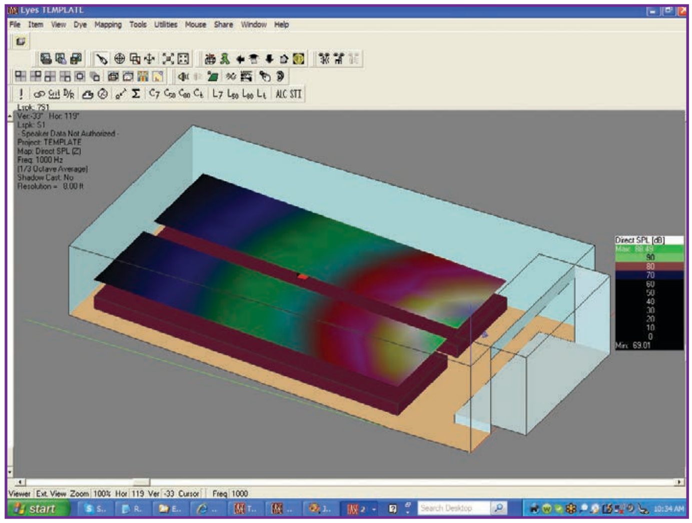


Photo 6: The sound pressure level (SPL) values or other parameters can be mapped onto the model's rendered view.

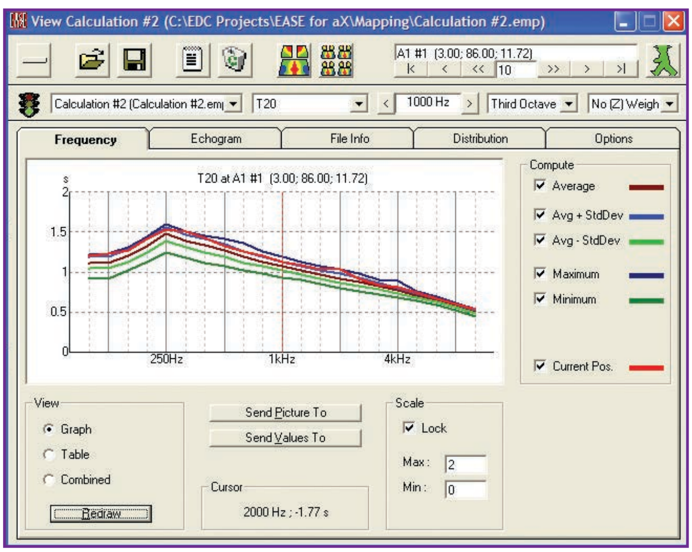


Photo 7: The T20 reverberation-time (RT) curves can be plotted vs frequency.

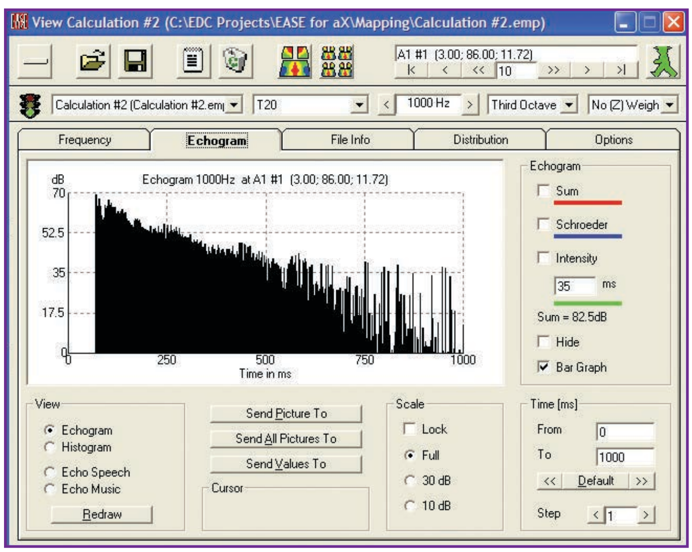


Photo 8: The echogram can be used to evaluate the analysis quality.

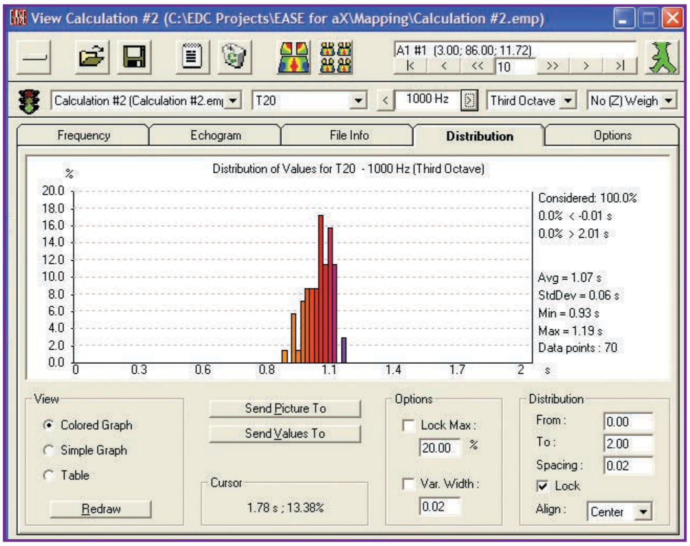


Photo 9: The statistical distribution plot helps evaluate reverberation-time (RT) calculations.

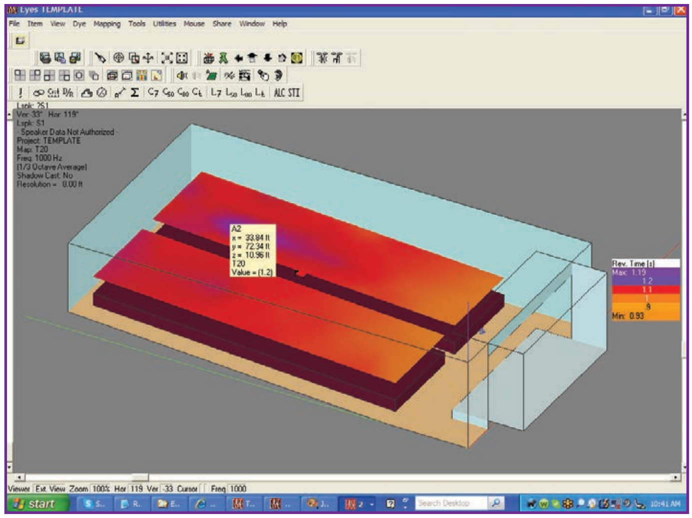


Photo 10: Using the "Peek" function, mapped parameter values at specific

users to position lights as desired to emphasize specific portions of the model. **Photo 3** shows the sample project with standard rendering. From the Eyes screen in which standard rendering is shown, users can set up analysis/mapping options, including selecting the sound source, audience areas for mapping, listener seat positions to be included in the calculations, the number of rays to be used, and the truncation time. For this article, we used the analysis and mapping functions of the optional AURA package.

Photo 4 shows the parameters for which curves or mapping are available once the calculations are completed. Users can view these parameters as plots of value vs frequency (see **Photo 5**) or as maps of the parameter value across the audience area (see **Photo 6**). Although the plots are shown for all octave bands, the data bandwidth plotted can be one-third-octave, full-octave, or three-octave data, as well as broadband. No weighting ("Z weighting") or A weighting can be applied. In **Photo 5**, the X, Y, and Z coordinates of the current position (for the red curve) are shown in the upper right. Data can be displayed as a graph, a table, or a graph and figure side-by-side, and can be exported as a picture file or as an Excel file. The graphing scale can be user-controlled.

Photo 7 shows the RT-vs-frequency plots for the sample project. **Photo 8** shows the corresponding echogram. Several analysis options (e.g., sum, Schroeder, and intensity) can be applied to the echogram. The RT distribution plot can help identify modeling errors or possibly non-obvious architectural features such as dual-decay slopes caused by coupled spaces (see **Photo 9**).

When a parameter has been mapped, the mouse

Resources

Acoustic Design Ahnert (ADA), www.ada-acoustic design.de/set_en/setbuero.html.

AFMG Technologies GmbH, "EASE—Software Versions and Modules," http://ease.afmg.eu/index.php/ea_compare_versions.html.

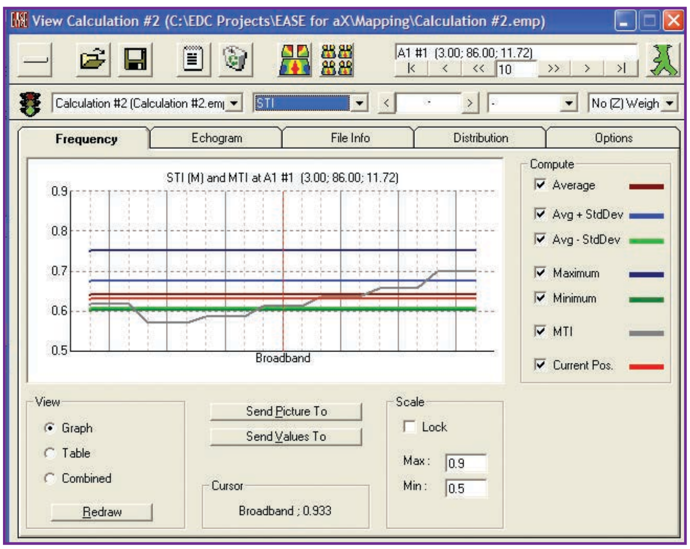


Photo 11: Speech intelligibility can be evaluated using the Speech Transmission Index (STI) or the Modulation Transfer Index (MTI).

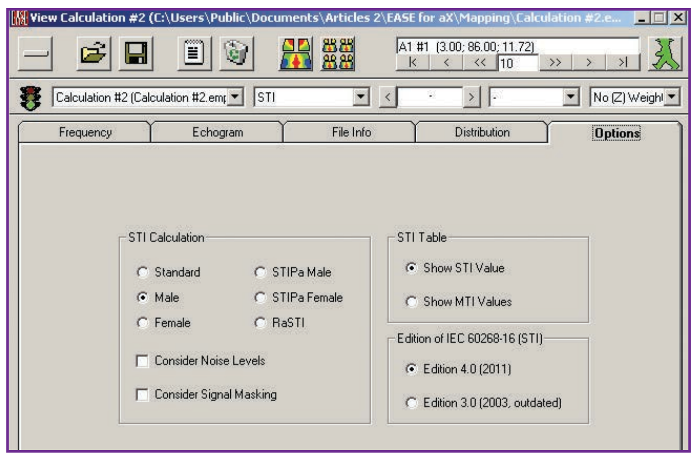


Photo 12: Several options are available for calculating Speech Transmission Index (STI).

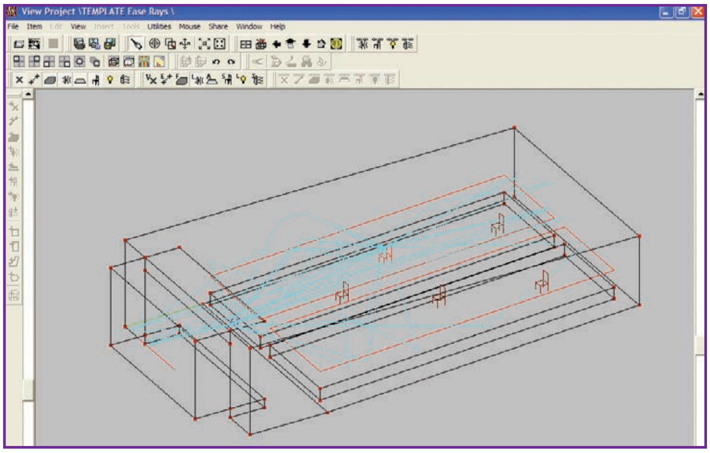


Photo 13: The light blue lines show paths of sound reflections.

can be used in the "Peek" mode, and the user can click and drag the mouse over the audience areas, showing the value of the mapped parameter at the cursor location. **Photo 10** shows the T20 RT map with a location being peeked.

Acoustics

The Speech Transmission Index (STI) or $\%AL_{CONS}$ can be used to evaluate speech intelligibility (see **Photo 11**. The Modulation Transfer Index (MTI) can be plotted as well. **Photo 12** shows the options available for calculating STI.

Ray-tracing tools within EASE can help identify which faces are involved in creating unwanted echoes. **Photo 13** shows a display that can be generated for such reflection studies.

Functions

Probe is an EASE tool that utilizes ray-tracing results to identify acoustical problems in the modeled space. It simulates measurements that could be made with a microphone in the actual space. Several displays are available through the Probe, including:

- Reflectogram
- Impulse response
- Energy-time curve (ETC)
- Waterfall
- Frequency response (for sound sources and even for each reflection)
- Pressure levels (L_{DIR}, L_7, L_{50}, L_{80}, L_{TOT}, and L_{SPLIT})
- 3-D Hedgehog (direction and relative level—horizontal, vertical, or 3-D)
- Phase angles
- Schroeder RT (includes a comparison with statistical values or measured data)
- Modulation transfer function (MTF)
- STI intelligibility predictions
- Clarity measures (C_7, C_{50}, and C_{80})

Both EASE Standard and EASE Jr. provide direct sound auralization, and EARS adds off-line and real-time auralization. AURA response now includes the ability to create Ambisonics second-order B-format files in addition to binaural impulse response files. To speed calculations, EASE can take advantage of multithreaded analysis processes on computers with multiple cores. For more information, visit http://ease.afmg.eu.