Computer Software used in Acoustic Analysis

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Presentation Cd included
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Introduction

Computers have come to be part of our daily lives; from ordering for items to opening doors, we find computers useful in one form or the other.

Many fields of study have taken advantage of the limitless potentials offered by computer applications.

In acoustic analysis, Computer simulations can be used to generate the spatial and temporal data describing the acoustical behaviour of performance halls, recording studios and any other interior spaces. Greater amount of information can be communicated to the designer by using computer graphics to display the multi-dimensional data obtained.

The potentials of computer analysis can be used for:

- Measurement and monitoring of occupational noise.
- Assessing and monitoring noise dosimetry—an instrument for measuring the amount of radiation absorbed by somebody or something.
- Environmental impact studies.
- Testing to assess compliance with noise ordinances.
- Architectural acoustics design.

Acoustic Simulation and analysis

Acoustical simulation is a technique that assists users in the evaluation of room acoustics or the performance of sound systems. This acoustical program can simulate the sound as it would be heard after the project is built. This is called auralization.

It has been shown that auralization methods (as depicted in the ODEON room acoustics program) are capable of reproducing the predicted room acoustical properties. Room acoustic parameters are well represented by the filters created for auralization, and that includes the variation with position as well as with frequency. When listening to the auralizations and comparing to dummy head recordings in the same position in the same room, the differences are hardly audible. Auralization techniques have matured to levels such that the human ear can hardly tell whether it is a simulation or not.
Overview of computer software used in acoustic analysis

Various computer applications or software as they are usually called have been developed over the years to perform different tasks in the study of acoustics. Some of these applications work based on existing / recorded sound (Audio processing) while others work from the first principles by generating analysing and processing sounds based on information fed to it. An example is ODEON - The Art of Acoustic Modelling. Below is a table containing the details and weblinks of several software used in acoustic analysis.

<table>
<thead>
<tr>
<th>Software</th>
<th>Details</th>
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<tr>
<td>ESI Group's AutoSEA2</td>
<td>Noise and Vibration Prediction Based on SEA</td>
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<td>EnviroMeasure's AVAAZ Innovations, Inc.</td>
<td>Software Products for Clinical, Research, and Industrial Applications Involving Speech and Spoken Language</td>
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<td>EnviroMeasure's Online Acoustics Software Tools and Demos</td>
<td></td>
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<td>Virginia PolyTechnic Institute and State University, Vibration and Acoustics</td>
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<td>Laboratories</td>
<td>Active Noise Control Experiment Shareware</td>
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<tr>
<td>ADEM</td>
<td>acoustic analysis and design software for engine mufflers and flow ducts</td>
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<tr>
<td>AcuVib</td>
<td>acoustic and vibration engineering toolbox</td>
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<td>AURORA</td>
<td>auralization software</td>
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<td>Integrated Sound Software</td>
<td>BEM (Boundary Element Method) software for acoustics</td>
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<td>CATT-Acoustic</td>
<td>room acoustics prediction and auralization software</td>
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<td>Collins &amp; Aikman's COMET</td>
<td>Boundary Element Software For Noise and Vibration Prediction</td>
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<td>Syntrillium</td>
<td>CoolEditPro/CoolEdit2000 digital audio software package</td>
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<td>Brüel Bertrand Johnson Acoustics</td>
<td>CORTI Health Conservation Program (HCP) management software</td>
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<td>Structural Research and Analysis Corporation</td>
<td>COSMOS design analysis software</td>
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<td>DSPCon</td>
<td>digital signal processing and data acquisition tools</td>
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<td>Echocsan</td>
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<tr>
<td>Software/Platform</td>
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<tr>
<td><strong>FIReverb Suite</strong></td>
<td>FIR generator and multi-channel reverb/mix convolver software</td>
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<td><strong>Fletcher and Galt’s Articulation Index</strong></td>
<td>software (freeware)</td>
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<td><strong>GFu-Kwun Hwang’s Fourier Synthesis</strong>, National Taiwan Normal University</td>
<td></td>
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<td><strong>FreeSEA</strong></td>
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<td><strong>Brüel Bertrand Johnson Acoustics HPD Select</strong></td>
<td>hearing protection device selection software</td>
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<tr>
<td><strong>ESI Group’s I-DEAS Vibro-Acoustics</strong> - Comprehensive Software for Solving Vibro-Acoustic Problems</td>
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<td><strong>Institut für Wiener Klangstil Musical Acoustics Software</strong></td>
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<td><strong>Ptolemy Services Jade 2</strong></td>
<td>environmental noise monitoring software</td>
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<tr>
<td><strong>Wave Imaging K-Space acoustics software</strong></td>
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<td><strong>Lake DSP</strong></td>
<td>acoustic analysis tools</td>
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<td><strong>LISA</strong></td>
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<td><strong>LMS International</strong></td>
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<tr>
<td><strong>MacNeal-Schwendler Corporation MSC/NASTRAN</strong></td>
<td>for Noise, Vibration, and Harshness (NVH) problems</td>
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<td><strong>The Mathworks</strong></td>
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<td><strong>QSound Labs QCReator</strong></td>
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<td><strong>Scientific and Technical Software SK-AVaM</strong></td>
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<td><strong>Peter Meijer's Sound synthesis software page</strong></td>
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Some of the above mentioned applications are briefly described in the subsequent sections.
ODEON - The Art of Acoustic Modelling

A reliable yet easy-to-use prediction software tool for indoor acoustics developed at DTU, the Technical University of Denmark. ODEON software simulates the acoustics of buildings. From the geometry and properties of surfaces, the acoustics can be calculated, illustrated and heard.

ODEON's prediction algorithms (image source method and ray tracing) allow reliable predictions at modest calculation times. ODEON is ideal for prediction of acoustics in large rooms such as concert halls, opera halls, auditoria, foyers, underground stations, airport terminals and industrial workrooms. For prediction of noise from large machinery in industrial environments, a special ray-tracing algorithm has been developed allowing modelling of surface and line sources.

ODEON can be used to predict the acoustics of new buildings, as well as to evaluate and recommend improvements in existing buildings. It is straightforward to use and takes care of the bookkeeping involved in stepwise improvement of models.

ODEON is available in three editions:

1. 7836 Auditorium Edition for calculation of a large set of room acoustical parameters. A number of graphical tools are built-in including a reflectogram, a 3D reflection path display and reverberation curve displays. This edition also provides built-in auralisation features.

2. 7835 Industrial Edition for environmental acoustics where SPL, SPL(A), T30 and STI are the important results. With this edition you can model point sources, line sources and surface sources, making it possible to model large and complex sound sources.

3. 7837 Combined Edition includes all the features found in the Industrial and Auditorium editions.

http://www.odeon.dk/
**Avisoft-SASLab Pro**

Avisoft-SASLab Pro is a powerful Windows application for investigating animal/human sound communication. It provides a broad range of processing and analysis tools that can dramatically increase the efficiency in extensive sound analysis projects.

It provides a comprehensive sound recording and analysis system; very flexible recording options, with real-time display of raw signal or spectrogram data.

![Figure 1: screen shot from the Avisoft-SASLab Pro interface](http://www.avisoft.com/soundanalysis.htm)

**How it works**

Below is a simplified step by step process of how Avisoft-SASLab Pro works

1. Record sound signals to the hard drive - either continuously or only when above a threshold. Either via your sound card, or via USB sound card, or UltraSoundGate
2. View and filter your data.
3. Analyse and classify sound events automatically.
4. Export data for statistical analysis.
5. Produce high quality spectrograms.
6. Edit clips, and alter them if required, for playback experiments.

**Features and capabilities**

It allows the capturing of sound from the environment quickly and easily making data collection flexible and easy. It has flexible recording options; generates and plays back artificial sound making construction or simulation of sounds easy.

[http://www.avisoft.com/soundanalysis.htm](http://www.avisoft.com/soundanalysis.htm)
Adobe Audition (formerly cool edit pro)

Originally developed by Syntrillium as Cool Edit, Syntrillium later released Cool Edit Pro, which added the capability to work with multiple tracks, as well as other features. Audio processing, however, was done in a destructive manner. Cool Edit Pro v2 added support for real-time non-destructive processing, and v2.1 added support for surround sound mixing and unlimited simultaneous. Cool Edit also included plugins such as noise reduction and FFT equalization.

Overview of Adobe Audition

Adobe Audition is an audio processing software that allows users the capability to analyze sound waves in their original form. Imported audio files (formats such as *.wav and *.mp3) are stored on different layers. Users can Record, mix, edit, and master digital audio files with powerful creation tools that bring flexibility and control.

There are over 50 audio effects. Properties such as amplitude, frequency, pitch, echo, flange, noise property and reverberation can be altered dynamically.

Upsampling:

This is one of the features of Adobe audition. It is the process of increasing the sampling rate of a signal. For instance, upsampling a 44 KHz frequency sound to 100 KHz.
The upsampling factor (commonly denoted by L) is usually an integer or a rational fraction greater than unity. This factor multiplies the sampling rate or, equivalently, divides the sampling period.

http://www.adobe.com/products/audition/overview.html
PAC WinSuite: Acoustic Emission Testing and Analysis Software

Physical Acoustics Corporation provides the most powerful, comprehensive and efficient software for acoustic emission testing, analysis and applications. The PAC software product line covers all the AE testing and analysis methods including the most advanced AE signal processing methods, e.g. FFT, neural networks, pattern recognition, wavelet analysis and moment tensor analysis that are publicly recognized and accepted in industries and research institutes. Additionally, knowledge-based software packages, such as MONPAC™ and AIMS, are also available for applications where procedural standards are required or extensive experience bases are needed to perform successful tests.

In summary, PAC software can be classified into the following:

- **PACwin Suite** - for general AE testing, analysis and applications
- **PACturnkey** - for knowledge-based turnkey systems and applications
- **PACremote** - for remote applications
- **PACspecial** - for special AE signal processing methods
- **PACshare** - for some special AE processing methods that are sharable with the public
Sound Studeo (version 1.0)

SOUND STUDEO® is a software we developed for educational and illustrative purpose. It performs basic sound calculations relating to the properties and behaviour of sound as well as simple analysis on sound levels within a space.

Several options are available to the user depending on the calculations to be performed. Guidelines specific to the various aspects of the software are presented in subsequent sections.

Interface

The interface is quite simple; consisting of two menus and three buttons. The menu’s are ‘File’ and ‘Help’ both containing the exit and program information commands respectively. Graphical representations are presented below.

Components of Sound Studeo®

Sound Calculations: Several sound calculations can be calculated using the software. The relevant topics are listed below:

1. Basic sound
   - Wavelength, Speed and frequency
   - Sound Intensity, Sound Power, Sound Reach
   - Sound Pressure, Nedium Density, e.t.c.
2. **Room and Auditorium Acoustics**
   - Reverberation time
   - Volume of Space
   - Total Surface Absorbtion

3. **Sound Analysis**
   With appropriate sound trapping hardware (such as a microphone), the sound level within a space can be estimated and observed. The sounds can be recorded into Wave (*.wav) audio files which can be played afterwards. The operations which can be performed include:
   - **New**: Open a new file.
   - **Record**: Record sound to the file.
   - **Stop**: Stop the recording or playback.
   - **Reset**: Delete the current file in use and reset the recorder.

4. **Sound Information**
   Also included in this package is a section on sound information which aids a better understanding of Acoustic concepts

   [Click here to install Sound Studio]
Conclusion

The use of computers in professional fields of practice has been on the increase in recent times, and the value has been immeasurable. The field of Architecture has not been left out. Computer software have found various applications in the field of Architecture; one major area being Acoustic Studies.

Acoustically efficient designs can be carried out by means of Real-time simulation and analysis performed with these software.

The immeasurable benefits derived form these software are the basis for their increased adoption within professional circles.

This report has been an evaluation of some of the existing software in use. As a means of promoting the use of computer software in acoustic analysis, we have been able to design a software to illustrate such.
References


- http://en.wikipedia.org/wiki/Adobe_Audition


- http://www.odeon.dk/

- http://www.acousticsbydesign.com/acoustics/acoustic-measurement.htm