Development and design of a loudspeaker using JMAG-Designer

Yoshihide Toyoshima

Onkyo Corporation, R&D Center

2-1 Nisshin-cho, Neyagawa-shi, Osaka 572-8540

yoshihide.toyoshima@jp.onkyo.com

Abstract :

We use JMAG-Designer mainly for development and design of magnetic circuits for loudspeaker. In this talk, we present an implementation background of JMAG-Designer and how to encourage the efficient use of it as an engineering design tool. In addition, we also introduce the case other than a loudspeaker.

ONKYO

Development and design of a loudspeaker using JMAG–Designer

JMAG Users Conference 2011

2011/12/8

Yoshihide Toyoshima

Onkyo Corporation

R&D Center

1

ONKYO   Summary

◆ Company Profile

◆ Development of Speakers

◆ Speakers and CAE

◆ Process of JMAG Introduction

◆ Expansion to Designers

◆ Analysis Example

◆ Speaker Analysis Points

◆ Application Examples Other Than Speakers

◆ Future Challenges

2

ONKYO   Company Profile

Onkyo Corporation

◆ Head office locations :
- Tokyo head office : Yaesu Chuo-ku, Tokyo
- Osaka head office : Neyagaw city, Osaka （R&D Center）

◆ Foundation : Year 1946

◆ Capital fund : 1,866,530,000 yen as of 2010/10/1

◆ Sales amount : 52,600,000,000 yen (Consolidation)

◆ Number of employee : 2,320 (Consolidation)

◆ Associated companies: 10 (domestic), 11 (overseas)

◆ Flagship products :

ONKYO SOUND & VISION CORPORATION

AV（Home-use audio equipments）
AV components and home theaters

ONKYO DEVELOPMENT & MANUFACTURING CORPORATION

Components （OEM）
Vehicle-mounted, home electronics speakers for video-game consoles, and petroleum exploration sensors

ONKYO DIGITAL SOLUTIONS CORPORATION

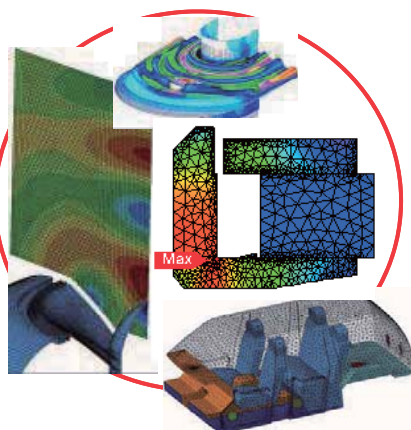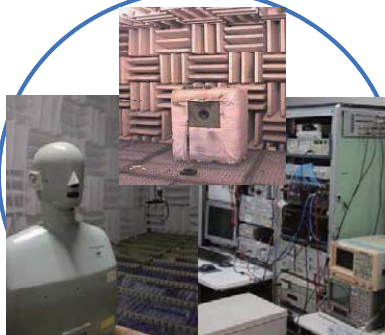PC related products
PC and sound devices

3

ONKYO   Development of Speakers

CAE

Material development

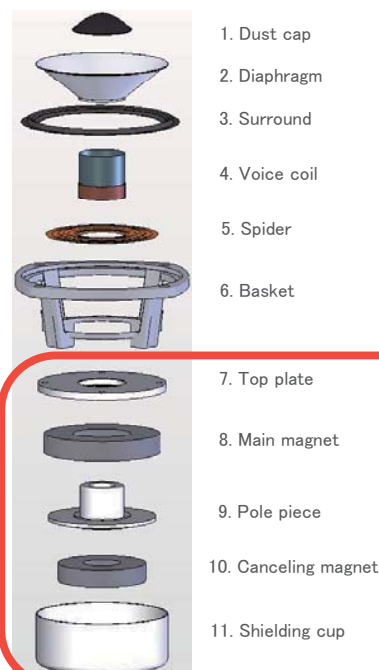Measurements, Analysis, and acoustic psychology

4

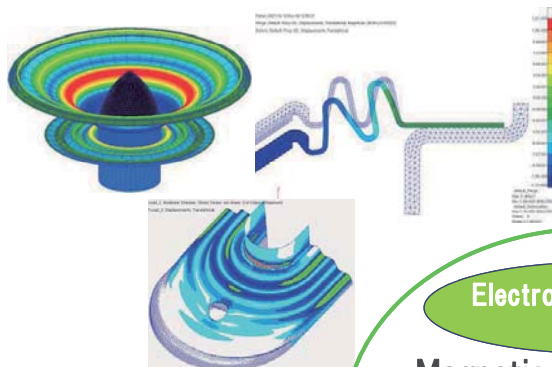Basic structure of
electrodynamic loudspeaker
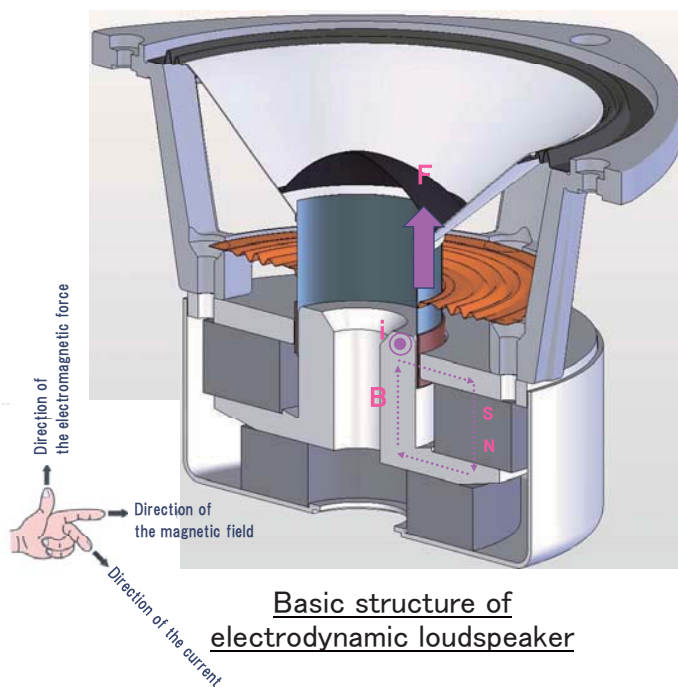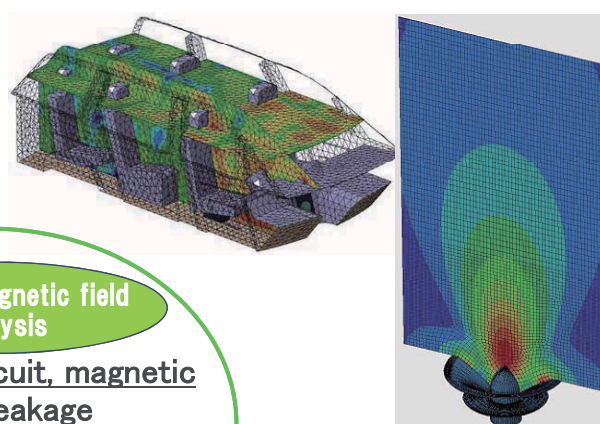
Magnetic circuit

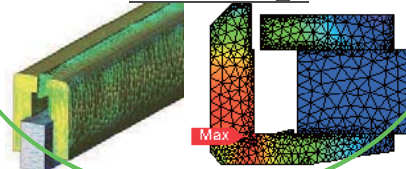Speakers and CAE

Structural Analysis

Vibration parts, heating design

Acoustic Analysis

Acoustic parts, room acoustic

Electro magnetic field analysis

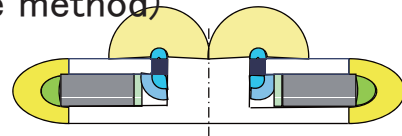Magnetic circuit, magnetic field leakage
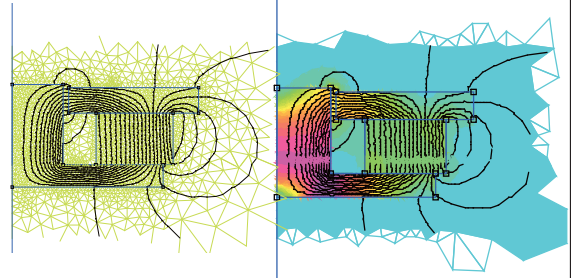
ONKYO　　　　　Process of JMAG Introduction

■ Manual calculations once (Permeance method)

> Calculated the operating point from Permeance coefficient of each parts, and obtained the magnetic flux density of magnetic gap.

■ 2D（Axisymmetric）FEM recently

> Most magnetic field circuit are round shaped, so analysis using 2D（Axisymmetric）FEM software was possible.

■ Necessity of 3D analysis

> AS the demand of compact speaker units, mainly the ones for TV built-in or theaters, increased, track, oval, or rectangle-shaped speaker units have been available to consumers.

Traditional analysis methods cannot deal with it!

Software that supports 3D analysis is required!

© 2011 Onkyo Corporation　　　　　　　　　　　　　　　　　　　　　　**7**

ONKYO　　　　　Process of JMAG Introduction

■ Reason I selected JMAG-Designer

> ◆ Analysis accuracy
>
> The analysis results agree with those obtained from the traditional analysis method, and cross-section analysis using JMAG is possible as well.
> （Consistency with the measurement value has been confirmed.）
>
> ◆ Extensive material library
>
> Not necessary to input the BH curves of nonlinear materials.
> Its reliability is high because material manufacturers supply this library.
>
> ◆ Easy links with 3D CADs
>
> Good compatible with 3D CADs right after introduction
>
> ◆ GUI that is similar with 3D CADs
>
> I Did not feel a feeling of strangeness as it was right after introducing a 3D CAD.
> Being the beginner of Studio result in the advantage by contraries.
>
> ◆ Running on Japanese system
>
> Advantageous in getting familiar with it.

© 2011 Onkyo Corporation　　　　　　　　　　　　　　　　　　　　　　**8**

ONKYO   Expansion to Designers

■ First impression is very important!

   ◆ Speakers on the market is so many and various, and designers are forced to use JMAG-Designer, but keep using it in the futuer depends on the first impression.

Unexpectedly easy and result is acceptable	It's difficult, and I cannot obtain the result.
↓	↓
I will continue to use this! (My skill will also be improved)	I will never use it! (Leave it to somebody else or quit it at that point.)

■ Innovator should focus on **making a good first impression**.

   ◆ If only one designer has a good impression, it spreads over through the grapevine.

   ◆ A bad impression may also spread over, and vice versa.

    9

ONKYO   Expansion to Designers

■ Reasons for a bad first impression

JMAG-Designer has a high level of perfection, and speaker structures are simple so the procedure is easy, but if something goes wrong then the situation is hopeless.

◆ Manual	Just seeing how thick it is makes me not want to read it.
◆ Help	I wouldn't understand it even if I tried it, so I don't look at it.
◆ WEB FAQ	I don't understand the search methods. (I do not search on the Web)

The manual and FAQ are good, but they cover a wide range, so it takes time for me to find the information that I want.

The contents are also technical, academic, and they have a good degree of credibility, but there are a lot of terms and contents that a designer cannot understand.

Designers are always trying to meet deadlines, so they need to solve problems fast.

    10

ONKYO — Expansion to Designers

■ How to make a first impression better

◆ Make a manual that is easy to understand and organized according to types of analysis and models.

◆ Enhance the FAQ specialized for in-house analysis.

◆ Hospitable in-house support.

Partial model analysis manual

Section analysis manual

FAQ in the in-house database

© 2011 Onkyo Corporation   *11*
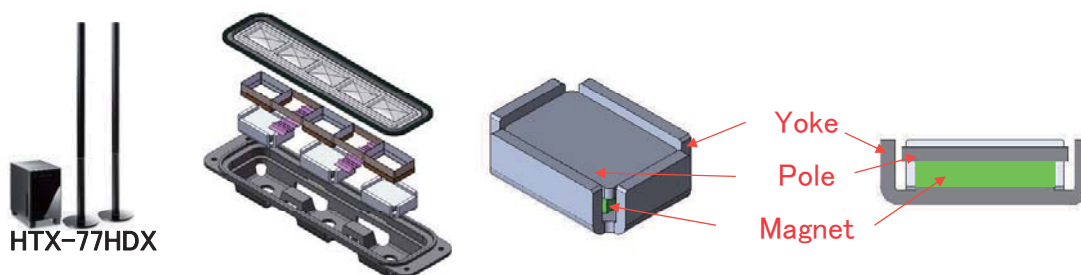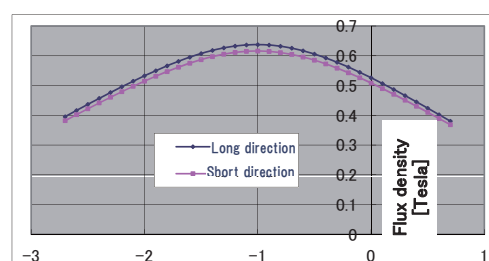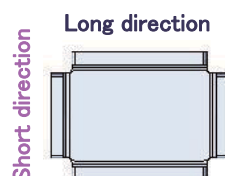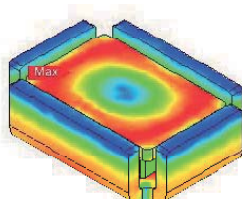

ONKYO — Analysis Example

■ Rectangular magnetic circuit analysis (static analysis)

◆ Magnetic circuit analysis of a Clustron unit, used in the home theater system HTX-77HDX

HTX-77HDX

Yoke
Pole
Magnet

◆ It is rectangular, so the characteristics differ in the long and short directions.

Long direction

Short direction

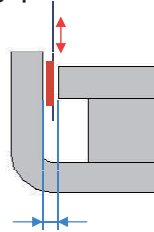© 2011 Onkyo Corporation   *12*

ONKYO   Speaker Analysis Points

■ The important thing is the magnetic flux density that bisects the magnetic gap.
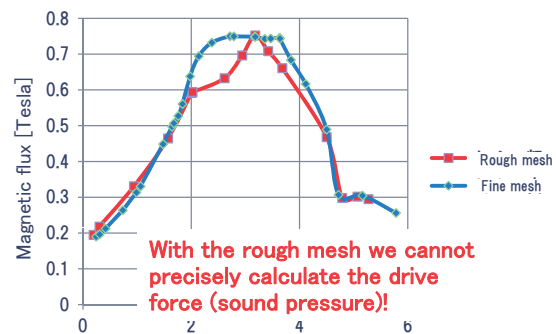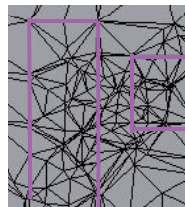
Drive force: $F = I \ x \ B \ x \ L$

[Current] [Flux density] [Effective coil length]

■ Often times the magnetic gap is several mm, so with the auto mesh it tends to become a single mesh.

◆ It is important to specify the mesh size for each part and utilize the adaptive mesh.

Rough mesh   Fine mesh

With the rough mesh we cannot precisely calculate the drive force (sound pressure)!
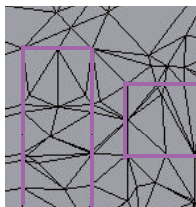
Magnetic flux [Tesla] — Rough mesh, Fine mesh

© 2011 Onkyo Corporation   *13*

ONKYO   Requests for JMAG

■ I want to output numerical information for planes.

◆ I want to extract grid point information for specified planes.

◆ At present I am outputting large amounts of section graphs and combining them.

■ I want to control a part of the mesh size for the air region.

◆ It would be nice if I could control the mesh size for the magnetic gap part without adding a new part.
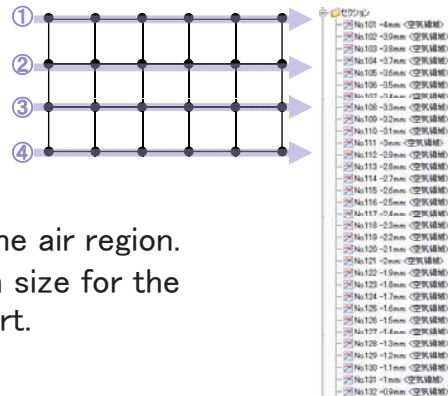
■ Further enhance the materials library

◆ Add materials and temperature dependence.

◆ The materials without data are hard to use.

■ Make the software faster

◆ When creating section graphs in large amounts, as mentioned above, I use the script tool and carry out loop processing, but there are a lot of times when I have to wait several minutes.

© 2011 Onkyo Corporation   *14*

Application Examples Other Than Speakers

ONKYO

■ Oil exploration sensors

Searching for where and how much oil (or natural gas) is buried.

・<u>Onshore search system</u>

　　Place several tens of thousands of vibration sensors on the ground, analyze the propagation waveforms from artificially caused vibrations, and search for structures in the earth.

・<u>Downhaul system</u>

　　Bury vibration sensors as deep as several km in the earth, analyze the propagation waveforms from artificially caused vibrations, and search for structures in the earth.

・<u>Marine search system</u>

　　Place an underwater microphone in the sea, and look for geological layers from sound waves reflected from the sea floor.
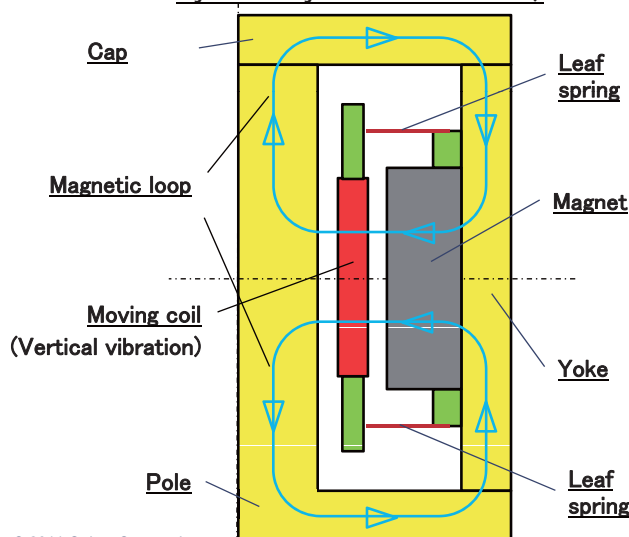
・<u>Sea floor search system</u>

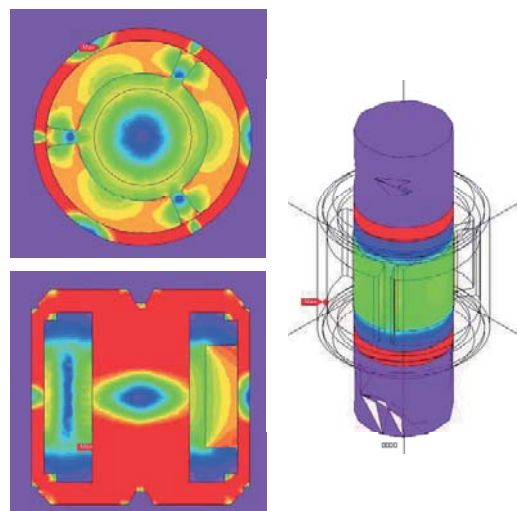　　Place a vibration sensor on the sea floor and search for geological layers.

15

Application Examples Other Than Speakers

ONKYO

■ The structure and basis of oil exploration sensors

　◆ It has an opposite basis from the speaker, as it takes out the coil's vibration as an induction current.
　◆ As with the speaker, we evaluate the magnetic gap and the magnetic flux density of the circuit.

・Sensor structure (Axial symmetry cross-section)　　　　・Analysis results

Cap, Leaf spring, Magnetic loop, Magnet, Moving coil (Vertical vibration), Yoke, Pole, Leaf spring

16

ONKYO Future Challenges

■ **Dynamic analysis (current)**

◆ The input signal for the speaker is an AC signal, so dynamic analysis is essential.
◆ If we can do AC analysis, then it becomes possible to analyze the inductance components for the coil.

■ **Dynamic analysis (structural analysis)**

◆ If we could account for the voice coil's movements as well, then it becomes possible to couple with other applications, which leads to an improvement in analysis accuracy for the speaker as a whole.
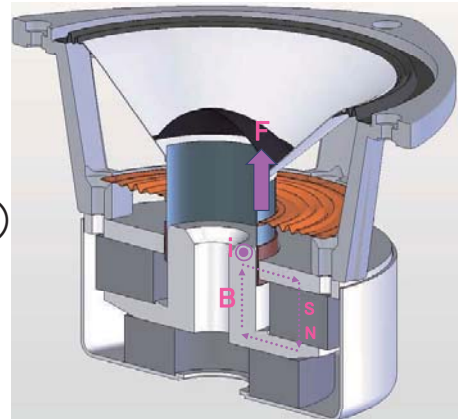
■ **Thermal analysis**

The basic structure of an electrodynamic speaker

◆ The efficiency of an electrodynamic speaker is typically under several percent, which is considerably low when comparing it to a motor with a similar construction. A large part is converted to heat, so this heat often affects the quality.
◆ There are times when actual measurements are possible, but if we can estimate things in advance with analysis, then it would be extremely valuable.

17

ONKYO.