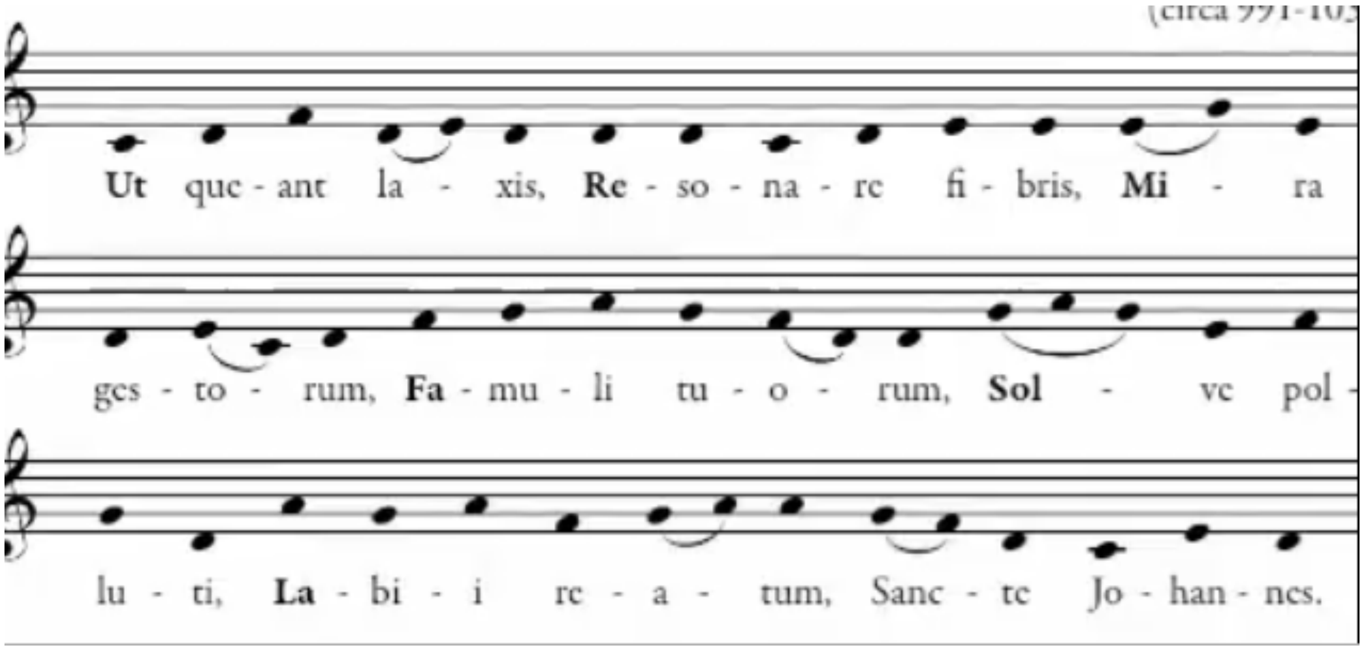
Technology and Art

Agenda

- History
- The Science of Musical Sound
- Ubiquitous Technology and Sound

History

Staff



Guido of Arezzo (991-1031) contributed considerably to the development of notation, developing solmization. Letters, syllables, and components of a verse are mapped on tone pitches and melodic phrases.

Mapping of vowels on tone pitches by Guido d'Arezzo

Pitches	G2	A2	B2	C3	D3	E3	F3	G3	A3	B3	C4	D4	E4	F4	G4	A4
Vowels	a	e	I	o	u	a	e	I	o	u	a	e	I	o	u	a
Vowels	o	u	a	e	I	o	u	a	e	I	o	u	a	e	I	o

Staff

- “Ut queant laxis”
- http://www.youtube.com/watch?v=SugtS3tqsoo&feature=related

The beginning of information science

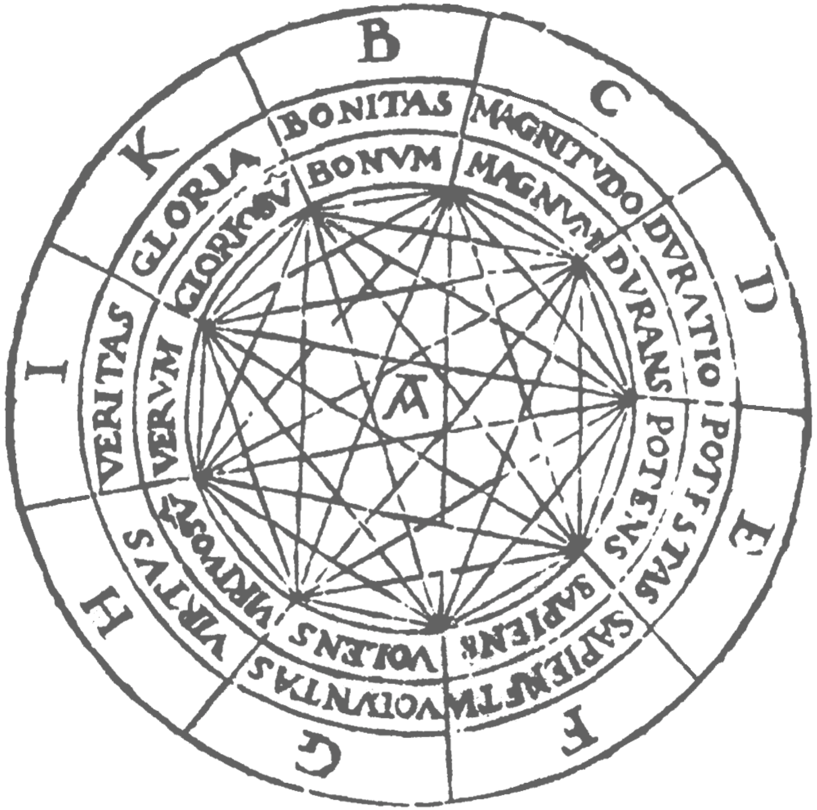


Diagram A of the “Ars Mafna.”

“trus is wise.” (Noun and adjective)

Rainmundus Lullus 1232[1] – June 29, 1315
“Ars Magna”

Each combination of the AM has an underlying alphabet of nine letters. The symbols from B to K <u>are semantic carries of expressions in different</u> categories, such as divine attributes, categorical determinants, question words, subjects, virtues, and vices.

Three diagrams and an arrangement of movable concentric circle form the working aids of the AM.

Ex Diagram A represents the divine attributes of the first category that can appear both as nouns and adjectives. The lines describe possible relations.

Lecture

(Computer, Algorithmic Composition and Electric Music)

The history of computers

Pascal, IBM Mainframe

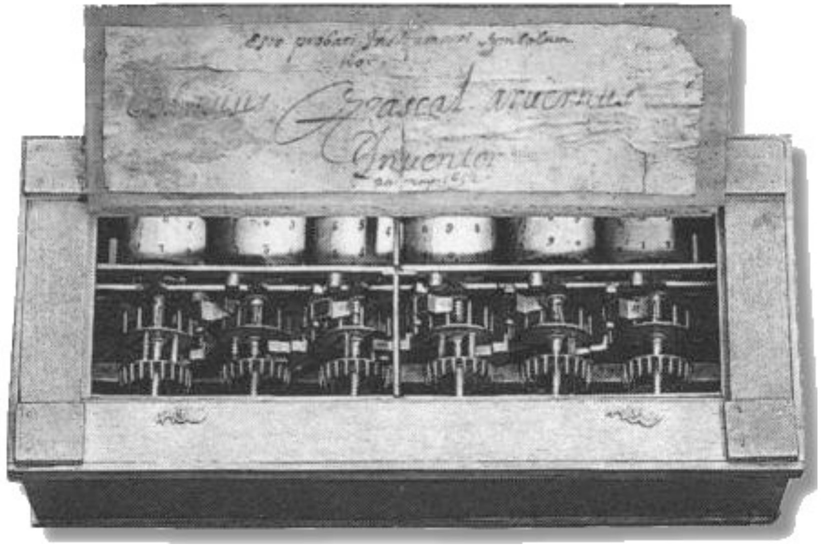
Sound Examples

(1) Algorithmic Composition
(2) Electronic Music

Current Situation

Computer

- 1623: Mechanical calculator
- Wilhelm Schickard invented the first known mechanical calculator, capable of simple arithmetic.
- A similar mechanical adding machine was made in the 1640s by Blaise **Pascal**. Still on display in Paris.



Pascaline

Computer for Computer Music

Max V. Mathews

Music I

1957 "Silver Scale", which is composed of a pure triangle wave, was made by IBM704

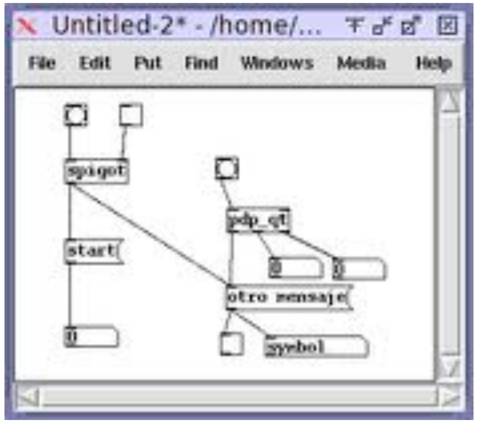
1958 Music II

Software platform for IBM7094

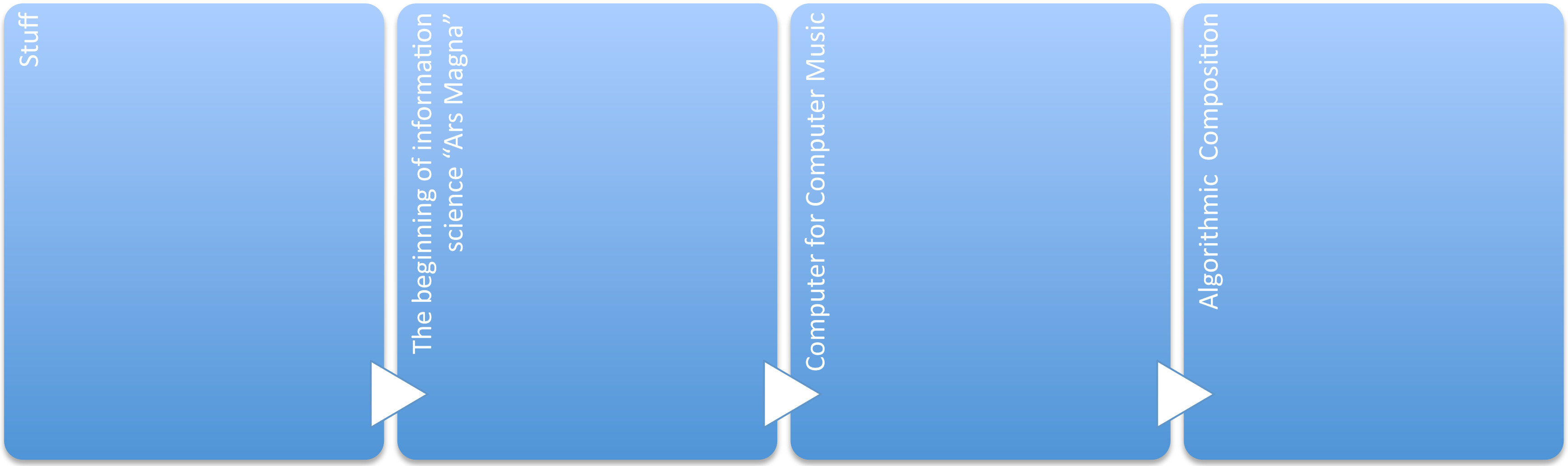
Sound Engine

- （1） Pure data
  http://crca.ucsd.edu/~msp/techniques.htm

- （2） Example



Process


Stuff
The beginning of information science "Ars Magna"
Computer for Computer Music
Algorithmic Composition

Algorithmic Composition

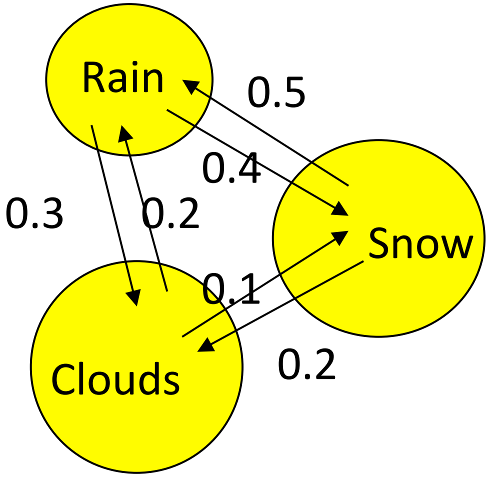
Compared with tonal music, how did composers make novel art works by algorithmic composition?

(Arnold Schoenberg , Anton Webern)

- Mathematical approach

Iannis Xenakis: “Enota“ (Example Listen)

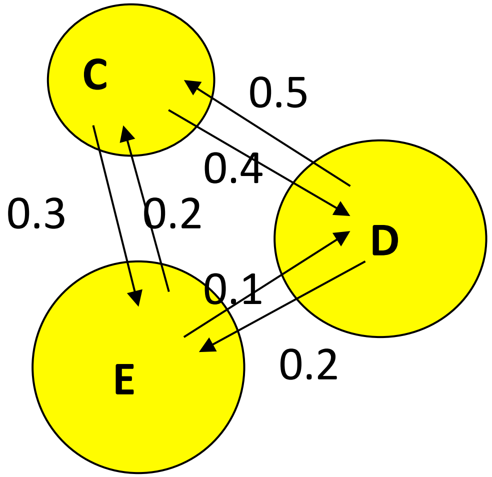
Algorithmic composition by mathematical approach (Markov Chain)



1 The method analyzes melody in music by a mathematical approach.

2 The algorithm estimates the next pitch based on the previous pitch using probability theory (Markov Chain)

	Rain	Snow	Cloud s
Rain	0.3	0.5	0.2
Snow	0.4	0.4	0.2
Clouds	0.3	0.1	0.6



	C	D	E
C	0.3	0.5	0.2
D	0.4	0.4	0.2
E	0.3	0.1	0.6

Electronic Music (Noise Music)

Intonarumori

Luigi Russolo

Noise music experimental composer

- **Luigi Russolo – Die Kunst der Geräusche (1913)**
- http://www.youtube.com/watch?v=VHLmitA3o6g&feature=related

Electronic Music

Music Concrete

is a form electric music by acoustic sound by Pierre Schaeffer. (1940–)

Sound Recording Technology

"etude aux chemins de fer"

http://www.youtube.com/watch?v=N9pOq8u6-bA&feature=related

The Science of Musical Sound

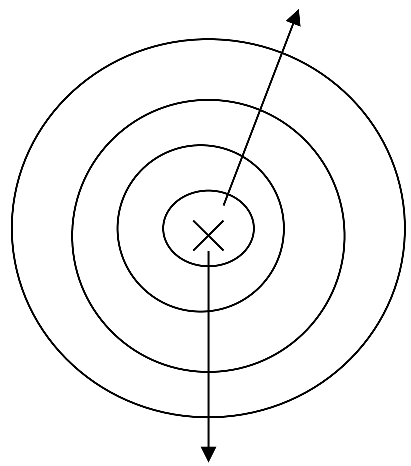
Physics of sound

- Sound is a mechanical wave that is an oscillation of pressure transmitted through a solid, liquid, or gas.

- A sound’s property is defined by frequency, wave length, amplitude, and velocity.

The propargation of the sound

- Sound is a sequence of waves of pressure which propagates through compressible media such as air or water. During their propagation, waves can be reflected, refracted, or attentuated by the medium.



Example of sounds

- Instrument's sound (ex) Piano, violin, trumpet, and horn
- Drum and cymbal

- An uncomfortable sound
  - Sound is composed of many different frequencies and amplitudes randomly.

- Noise: the sound of wind, etc…

Keyword: Pitch
Pitches are usually quantified as frequencies in cycles per second, or hertz.

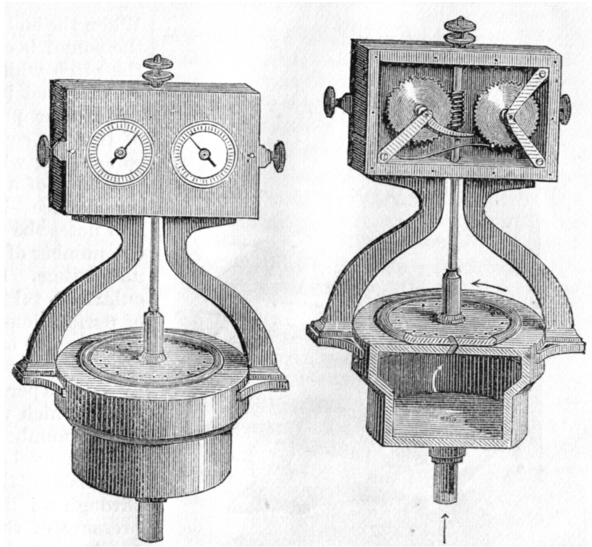
Harmonic sound is a periodic vibration, on the other hand noise is a non-periodic vibration.

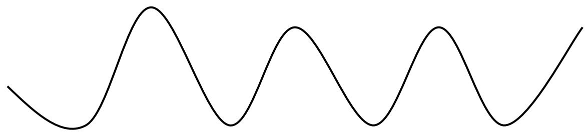
Frequency, Period, and Amplitude

Example Siren

Improved siren by Charles Cagniard de la Tour (1819)

Cagniard de la Tour invented, about 1819, “the improved siren”, as he named it, and used it for ascertaining the number of vibrations corresponding to a sound of any particular pitch.





Periodic vibration

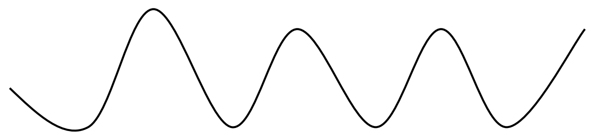
Pitch and Waveform

Edgard Varese - Ionisation

http://www.youtube.com/watch?v=a9mg4KHqRPw&feature=related

Pitch and Waveform

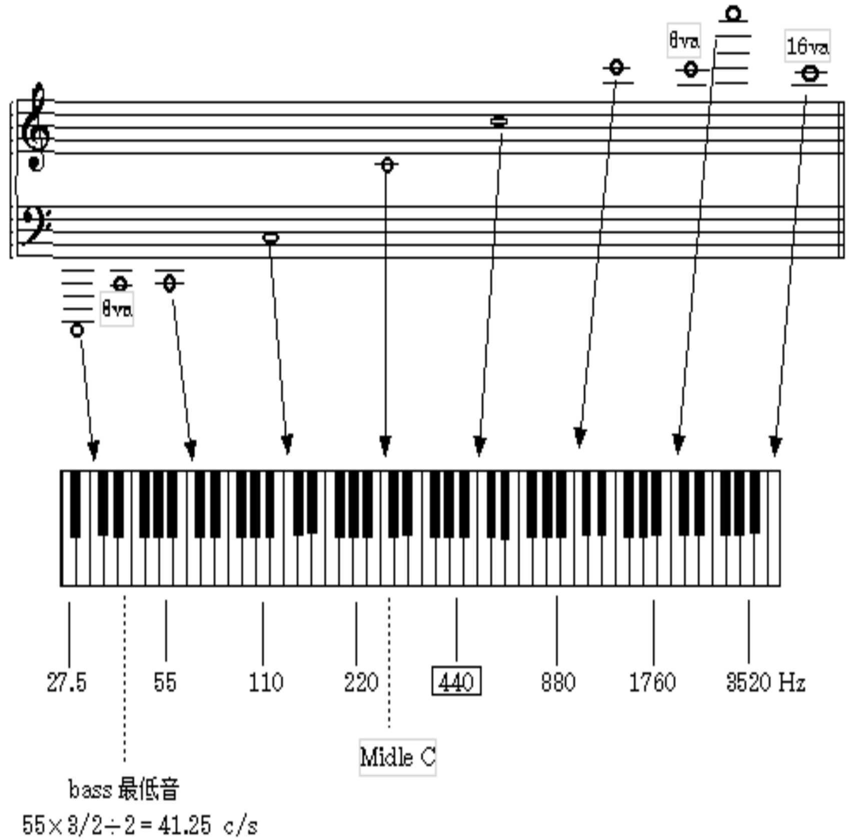
- Pitch?
- Musical melody. Higher scale or lower scale.
- Physically, the meaning of a pitch is frequency.



Periodic vibration

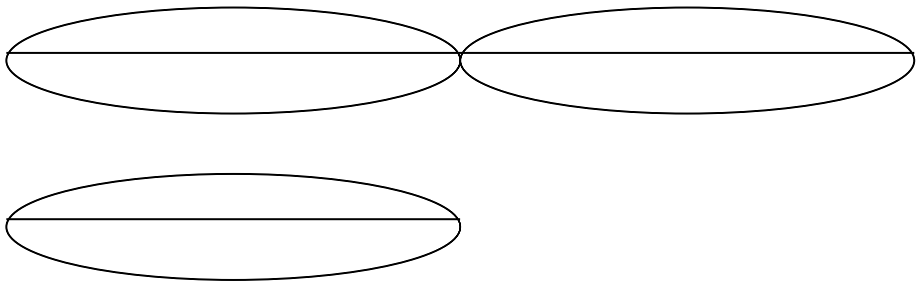
Pitch and Waveform

- Example
- The A above middle C is usually set at 440 Hz
- In the case of 220 Hz, the frequency is one octave lower than 440 Hz



String’s vibration

- Frequency＝k X Tension)/(LengthX√Mass per length)
- 440 (C) ＝k X (√Tension)/(LXLengthX√Mass per length)
- 528 (E♭) ＝ k X (√Tension)/((5/6)LXLengthX√Mass per length)
- 220 (C‘) ＝ k X (√Tension)/((1/2)LXLengthX√Mass per length)

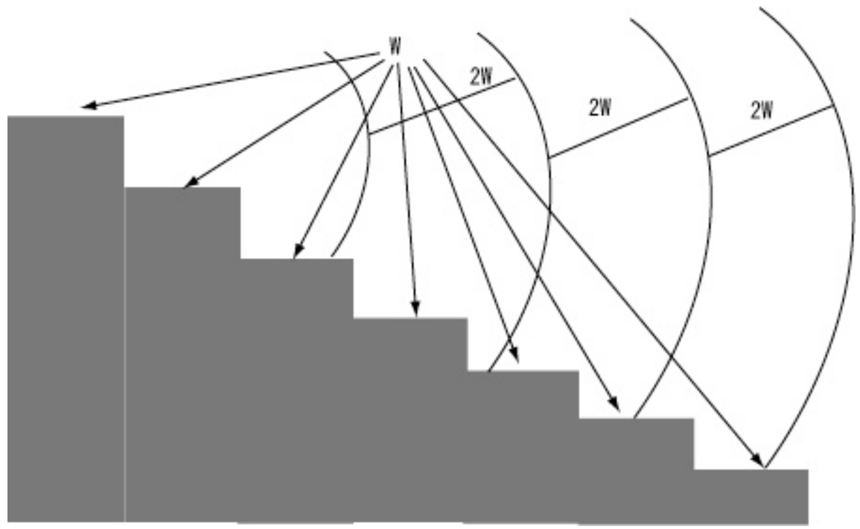


Length L （周波数 C)

Length 1/2L（周波数 C')

Echo

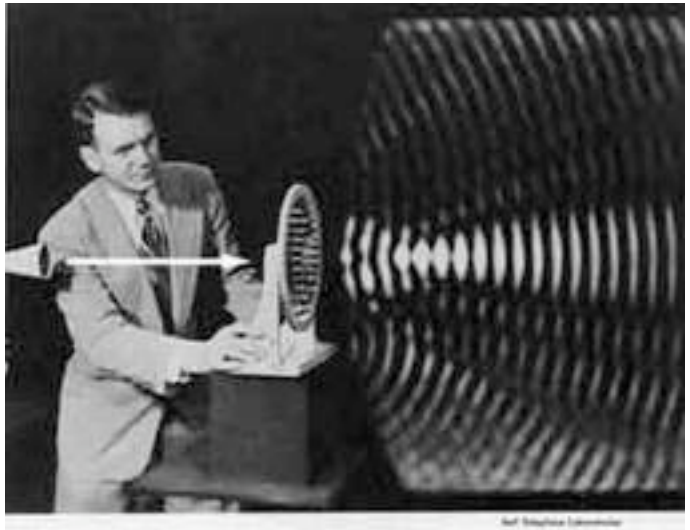
In audio signal processing and acoustics, an echo (plural echoes) is a reflection of sound, arriving at the listener some time after the direct sound. Typical examples are the echo produced by the bottom of a well, by a building, or by the walls of an enclosed room. A true echo is a single reflection of the sound source. The time delay is the extra distance divided by the speed of sound.



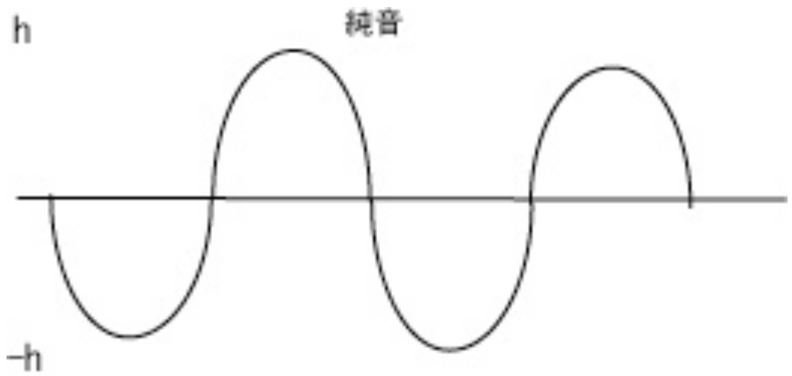
T=2W/V

f = v/2W

Sound Physics



Sine wave



Sine wave or pure wave
In relation to frequency, the period T satisfies
$f=1/T$

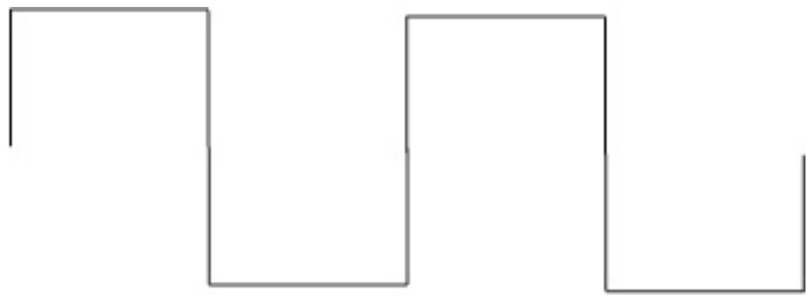
Example 1: Sine wave (440 Hz) is
$T=(1/440)=0.0022727$ (sec)

Example 2: 1/1000 Sec sine wave is
$f=1/0.001=1000$ Hz

Square wave

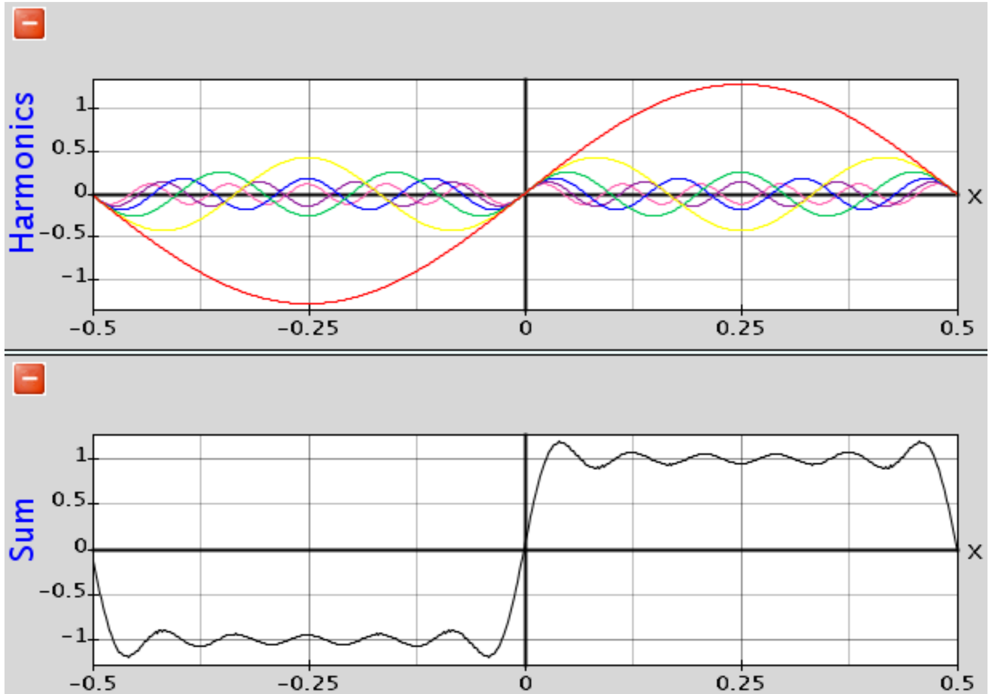
- Jean Baptiste Joseph Fourier

- Any wave can be decomposed into a fundamental sine wave and harmonic overtones.



Square wave is also...?

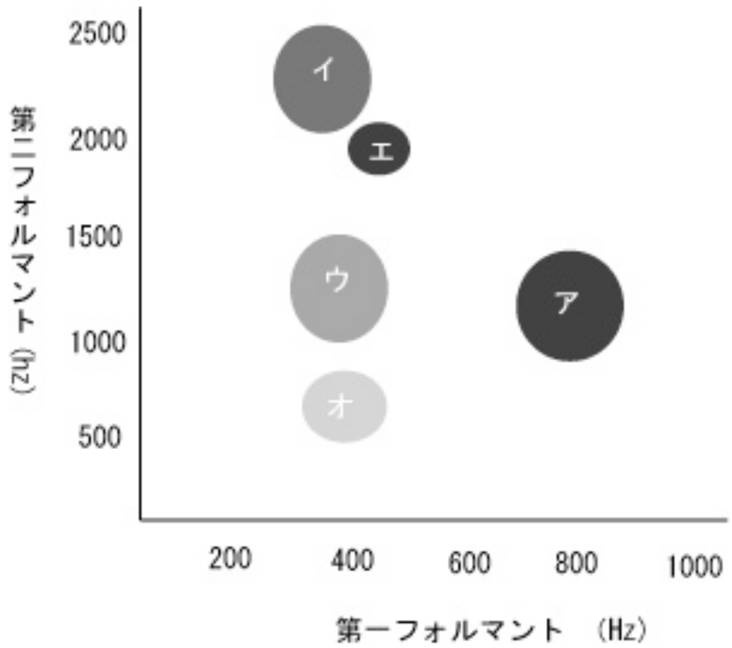
Square wave



Example 1 If we generate pure sine waves of appropriate amplitudes and frequencies, we can create a square wave as the sum of the sine waves.

Voice (Formant)

- Formants are the distinguishing or meaningful frequency components of human speech and of singing.



How do we analyze frequencies in sounds? (Acoustic Resonance)

- Acoustic resonance is the tendency of an acoustic system to absorb more energy when it is forced or driven at a frequency that matches one of its own natural frequencies of vibration (its resonance frequencies) than it does at other frequencies.

In analyzing frequencies in sound, we used acoustic resonance.

Helmholtz resonance

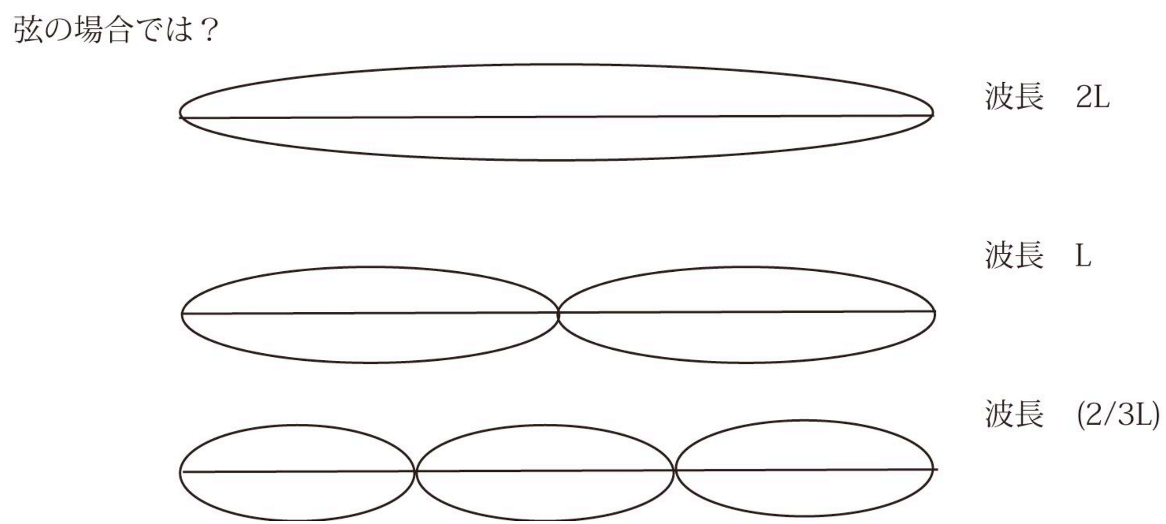
- Frequency analysis by acoustic resonance.
- When air is forced into a cavity, the pressure inside increases. Once the external force that forces the air into the cavity disappears, the higher-pressure air inside will flow out. However, this surge of air flowing out will tend to over-compensate, due to the inertia of the air in the neck, and the cavity will be left at a pressure slightly lower than that outside, causing air to be drawn back in. This process repeats, with the magnitude of the pressure changes decreasing each time.

Fig. 16a.

andere *b* ist trichterförmig und so geformt, dass man sie in das Ohr einsetzen kann. Die letztere pflege ich mit geschmolzenem Siegellack zu umgeben, und wenn dieser so weit erkaltet ist, dass er zwar mit den Fingern ungestraft berührt werden kann, aber doch noch weich ist, drücke ich diese Oeffnung in den Gehörgang

Fig. 16b.

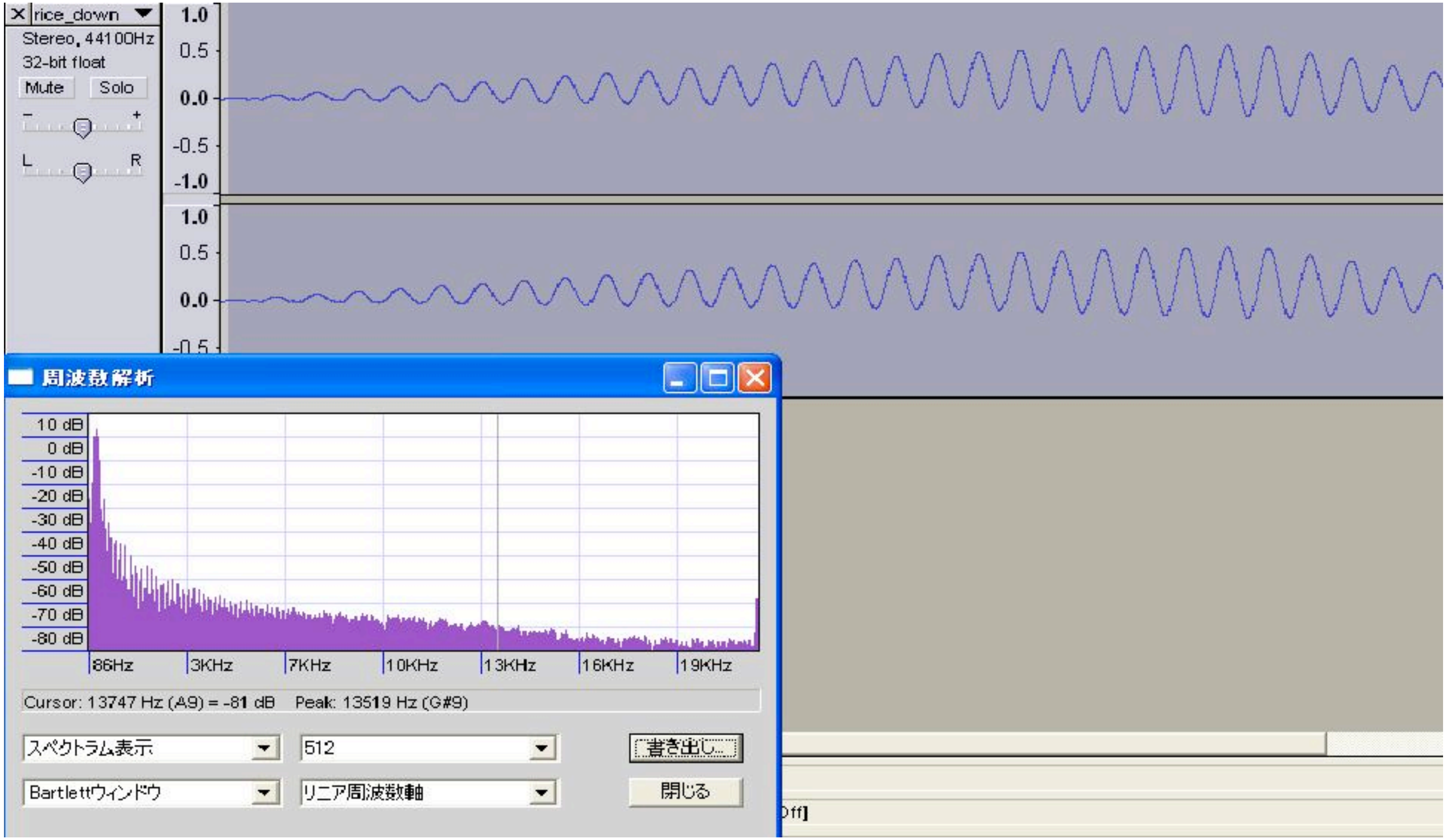
In the case of a string (resonance)



- Fundamental frequency representation

  f=(v/2L)
- If we strum the string, the vibration includes the fundamental frequency, which is equal to 2L, and, because of resonance, many harmonic overtones based on this fundamental frequency.

Frequency Mesurement



Ubiquitous Technology and Sound

The current situation in our life

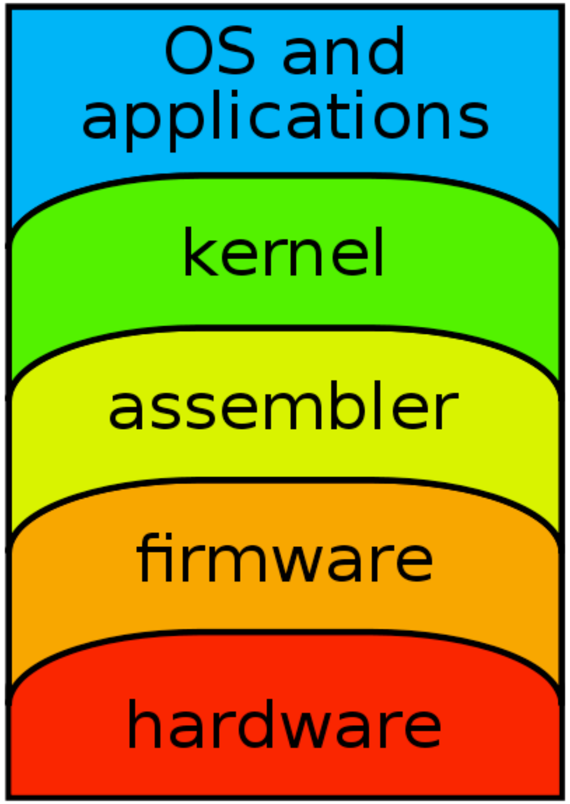
- Development of personal computers, software, and hardware

- Spread of the Internet

- Miniaturized digital devices

Development of personal computers, software, and hardware

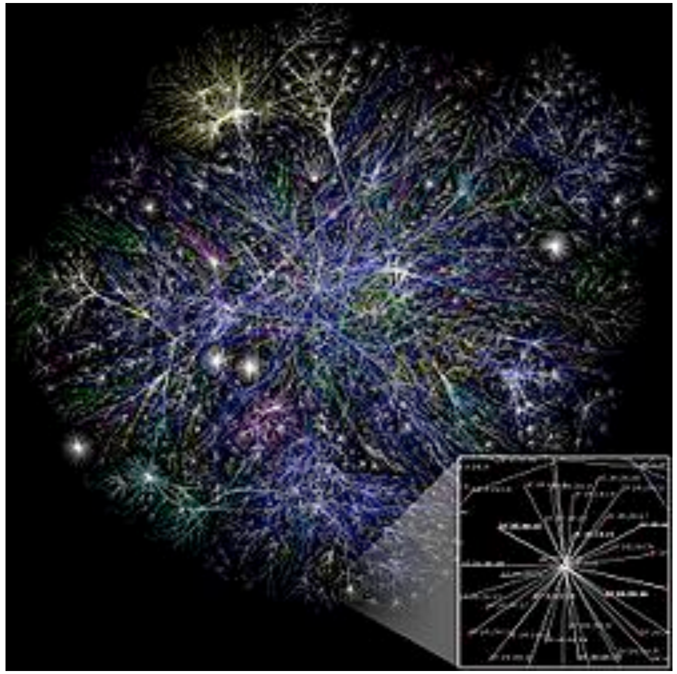
- Electrical devices enable the recording of huge amounts of data to generate and synthesize novel sounds by algorithms in real time.



Spread of the Internet

- The Internet has grown since 1960.

Computers enable users to obtain data from distant locations in real time.



Tree of routing paths through
a portion of the Internet as visualized
by the Opte Project

Ref Wikipedia

Miniaturized digital devices

- Computers have continued to be improved, for example, in terms of weight and processing speed.

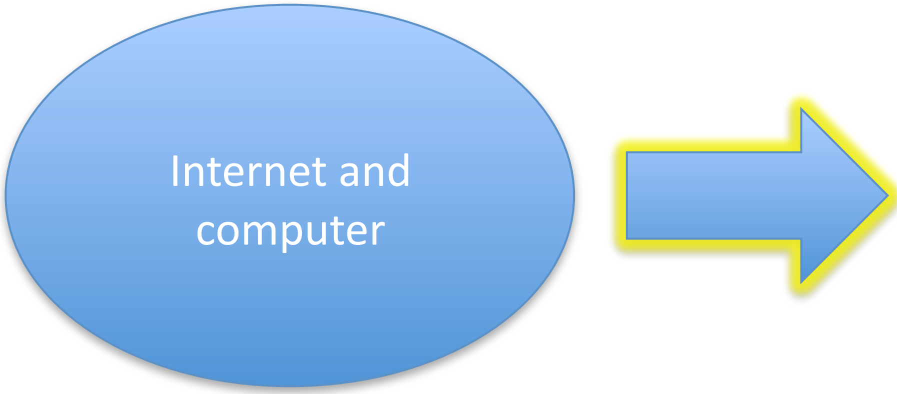
Thus…

- We can easily obtain a high spec computer, smart phone, and so on.

- We can communicate with many people by the Internet.

- We can share information with each other, for example, through social networks.

Technology



- The Web, PDAs, and so on.

Time and Space

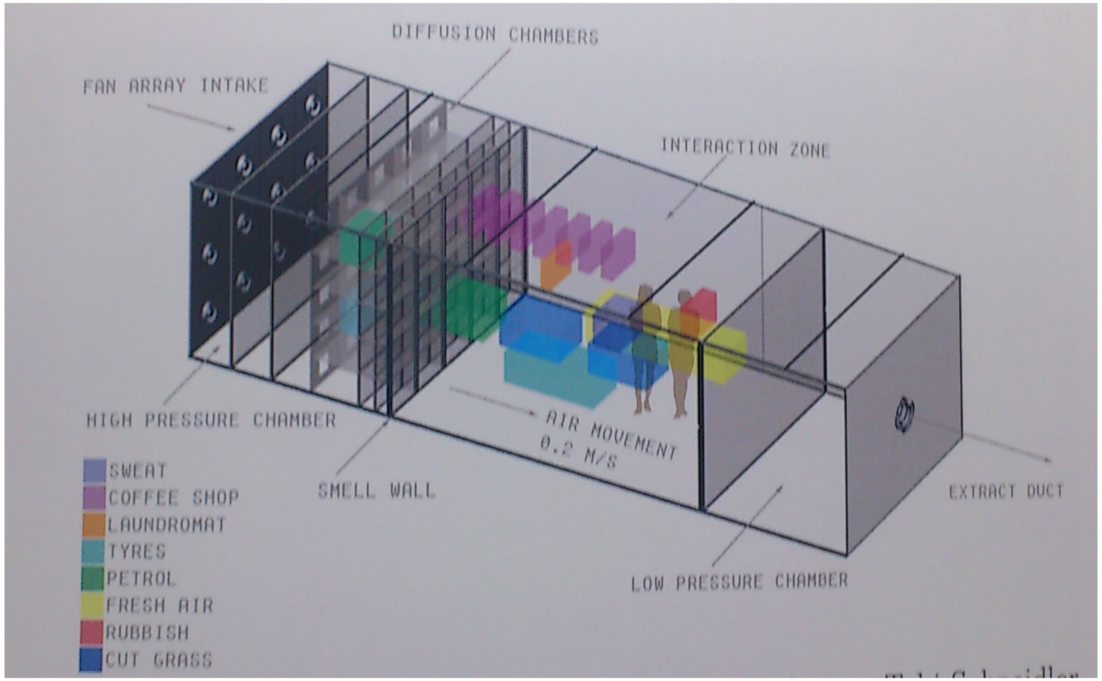


Fig 1 Type 1

Type 1 Electronic devices are embedded in walls, floors, and ceilings, and these devices deliver services to users.

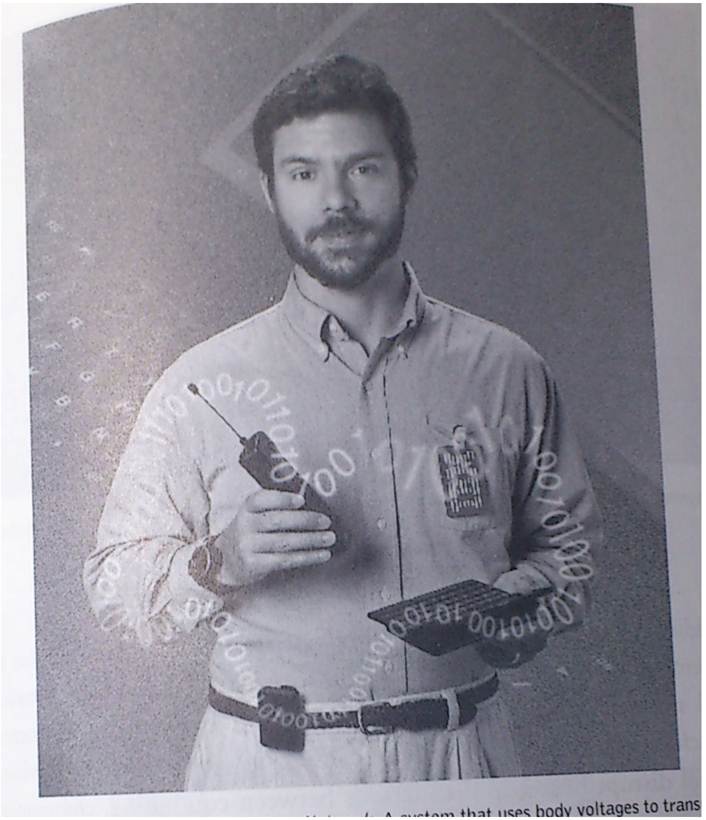
Type 2 Electronic devices are embedded in clothes, and users control the devices.

Interactive Communication Experience

- ICE, permanent installation by Klein Dytham and Toshio Iwai, Bloomberg Headquarters, Tokyo, Japan

Boundary Function

Time and Space



Type 2

Thomas Zimmerman

IBM’s Personal Area Network. A system that uses body voltages to transmit and communicate data by touching. The system can also power itself by capacitance generated by walking.

Media art and media design

- Media art and design have benefited from current computer technology.

- Media artists and designers have produced artworks and products by using programming.

Conclusion

- In order to gain a deep knowledge of computer music or media art, we also need to learn about a broad spread of subjects, including physics, engineering, design, and fine art.
- I would like to encourage you to learn about information technology and the principles of nature to order to produce works of art.

Example

- RYOJI IKEDA : THE TRANSFINITE
- http://www.youtube.com/watch?v=omDK2Cm2mwo

Report

I gave a lecture on ”Science and Computer Music”. Please summarize a report about the lecture, and submit the report in one page pdf file.