# Auditory Display
# For Human Computer Interfacing

## November 10, 1999



## First, Some Terms: The Senses

**I. Visual**

N: Vision
V: Visualize, Image, View, Display

**II. Auditory**

N: Hearing, Audition
V: Hear, Listen, Play, Present, Sound





**III. Haptic**

N: Kinesthesis + Taction
V: Feel, Touch, Manipulate

**IV. Olfactory**

N: Olfaction, Smell
V: Smell, Sniff, ..

**V. Gustatory**

Yummy!

## Auditory Display Terms

**I. Auralization**

Realistic "rendering" of sonic environments.

**II. Auditory Icons**

Real World Sound Events as Signals

**III. Earcons**

Abstract, Hierarchical Sonic Grammar

## IV. Audification/Sonification

Data --> Sound

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## I. Auralization

Realistic "rendering" of sonic environments.

Audio "Ray Tracing" from source(s) to listener(s), including effects of diffraction, diffusion, etc.

(Or just another confused definition of Audification, Sonification, Scientific Auditory Display, etc.)

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## II. Auditory Icons

Use of recordings of real-world sounds to signal events. Real-world sounds, if selected correctly, can carry lots of intrinsic meaning because of our experience with them.

Typical System: Gaver's Sonic Finder System

Examples: Glass Breaking for error, Rooster





Crowing
for schedule alarms, "Yippee" for successful compile,
"NDope" for errors on compile, etc.

Problems with real-world sounds are that they don't mean the same thing to all people (like icons too), they can become tiresome, sometimes they take more
time to play than the information they carry, etc.

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## III. Earcons

More abstract (than auditory icons) sonic events. These are Hierarchical, and can be concatenated and mixed to build up complex meanings.

Examples:
The work of Meera Blattner (the inventor of the term Earcon)
and Stephen Brewster's page and thesis on Earcons.

## IV. Sonification

**The use of data relationships to auditory relationships
for the purpose of communicating and/or comprehending
relations in the domain under study.**

### Some Existing Auditory Display Systems

**CAITLIN: A Musical Program Auralisation Tool to Assist Novice Programmers with Debugging
Department of Computer Studies, Loughborough University**

**ADSL: An Auditory Domain Specification Language for Program Auralization
Syracuse University**

**LSL: A Specification Language for Program Auralization
Purdue University**

**Sonnet: Audio-Enhanced Monitoring and Debugging
IBM Watson**

**FAUST: A Framework for Algorithm Understanding**





**and Sonification Testing
Princeton**

**LISTEN: Sounding Uncertainty Visualization
MUSE: A Musical Data Sonification Toolkit
University of California Santa Cruz**

## V. Some Psychoacoustics

**Human hearing is sensitive to (in rough order):**

- **Frequency, Pitch**

  **50 Hz. to 4KHz
  0.5% changes perceived**

- **Time**

  **0.2 events/second to 20 events/second
  4% changes perceived**

- **Spatial Location**

  **360 degrees in the plane of our ears, above and below, and distance too.
  a few degrees (more on this in 3D Lectures**

- **Intensity, Loudness**

100 dB (factor of 10,000,000,000)
20% changes perceived

- **Timbre**

  Defined as "everything which is not pitch or loudness"
  Impulsive vs. sustained, nasal, bright, ...

- **Voice Quality**

  breathy, creaky, strained, ...

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## Web References:

Home Page of the International Community of Auditory Display
Specifically check the Annotated Bibliography Here.

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## Some Non-Web References Made from Dead Trees:

"Auditory Display: Sonification, Audification, and Auditory Interface"
Santa Fe Institute Studies in the Sciences of Complexity
Proc. Vol. XVIII
Reading, MA: Addison-Wesley, 1994.

"Multimedia Interface Design"
M. Blattner and R. Dannenberg eds.
Reading, MA: ACM Press/Addison-Wesley, 1992.

"Auditory User Interfaces"
T. V. Raman
Kluwer Academic Publishers, Boston, 1997.

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## Next up: How to Synthesize Sound

Back to Princeton General Information Section