Sonification Lab Overview

Prof. Bruce N. Walker
Georgia Tech, Atlanta

GT Sonification Lab
sonify.psych.gatech.edu

Who we are…

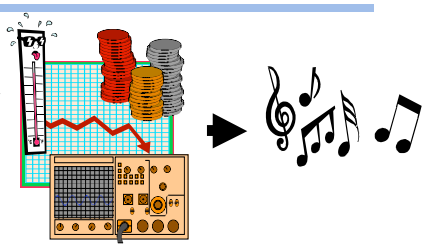
- School of Psychology and College of Computing at Georgia Tech
- PhD, MS, and undergrads from Psychology, Computer Science, Engineering, Design, HCI, etc.
- "How can we most effectively use sound to convey information?"

Research Areas

- Sonification
- Auditory Interfaces
- Human-Computer Interaction
- Non-traditional Interfaces

Sonification

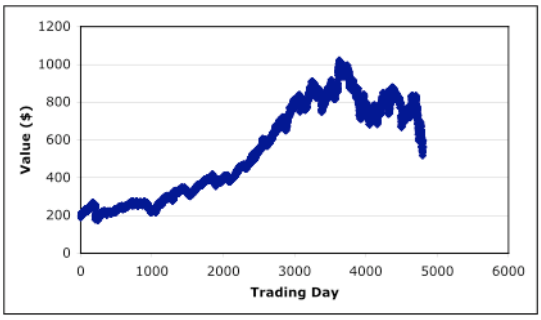
- "Auditory display of quantitative information"



- Compare to visualization
  - Weather data — Demo: Nebraska
  - Stock market data — Demo: DJIA
  - Election results — Demo: Florida 2000
  - Factory process monitoring and control
  - Surgical assistance — Demo: Tactical Surgery
  - Brainwave sonification — Demo: Bruce's brainwaves

Sonification in Education

- Math & science are largely visual
- Blind students are shut out
- Need a system to turn data into sound
- "Auditory Graphs"



Sonification Design Issues

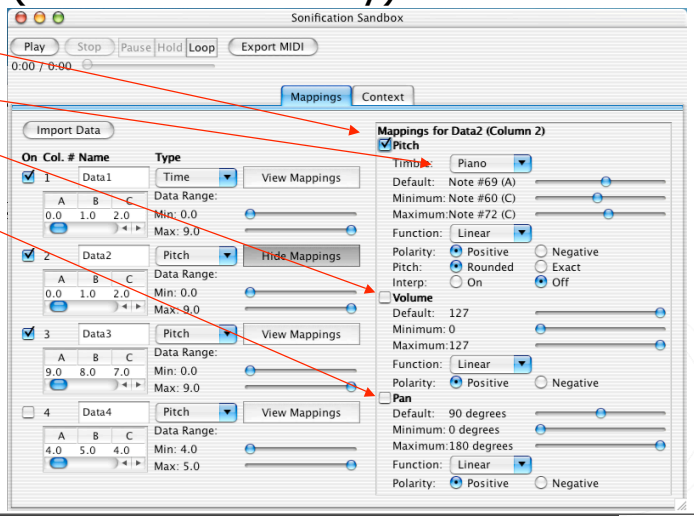
- Mapping
  - Data dimension --> Display
    - e.g., Dollars --> Pitch
- Polarity
  - Increasing pitch = increasing or decreasing $?
- Scaling
  - Double the pitch = double the $?
- Context
  - Equivalent to tick marks, axes, trend lines
- Training
- Interaction techniques

Sonification Sandbox

- Software to create, manipulate, and export auditory + visual graphs
- Applications:
  - Science and math education
  - Data exploration
  - Measuring efficacy of various sonification techniques and parameters

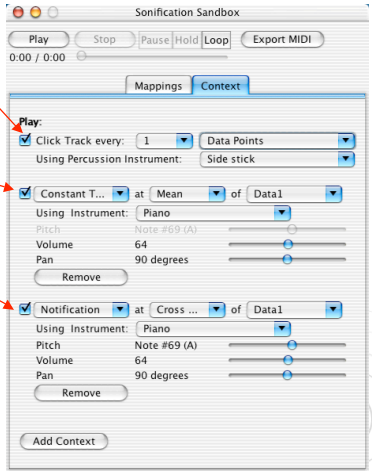
Mappings in the Sandbox

- Can assign default, minimum, and maximum (scale automatically) for:
  - Pitch
  - Timbre
  - Volume
  - Pan



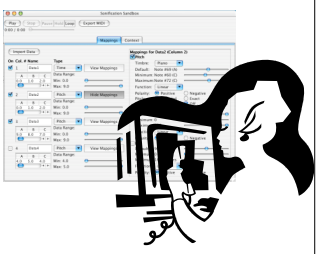
Context in the Sandbox

- Options for context:
  - Click Track (x-axis)
  - Reference Tones (y-axis)
  - Notification (at Mean, Min, Max)



More Features of Sandbox

- Integrated spreadsheet
- Visual graphing output
  - Both static & animated graphs
- Multimodal input
  - Speech interface -- control the software by voice
  - Accessibility features (where possible)
  - Keyboard navigation & shortcuts



Audio Abacus

- "Point Estimation" problem remains
- Display specific data values
  - e.g., exact stock price, precise temperature
- Spatialized sound, pitch-to-value mapping based on abacus

Audio Abacus Concept

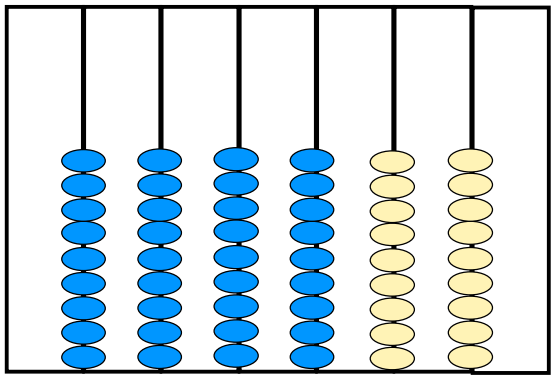
- Each digit or "place" in a number is mapped to a single note in a brief melody
  - e.g., 189:

    "1" (100) mapped to first note
    "8" (80) mapped to second note
    "9" (9) mapped to third note.

- Each note can be one of 10 pitches, so there is a one-to-one mapping of number to pitch
  - Compare to the beads on the simple abacus
  - e.g., 0=MIDI note 60, 1=MIDI note 61, etc.

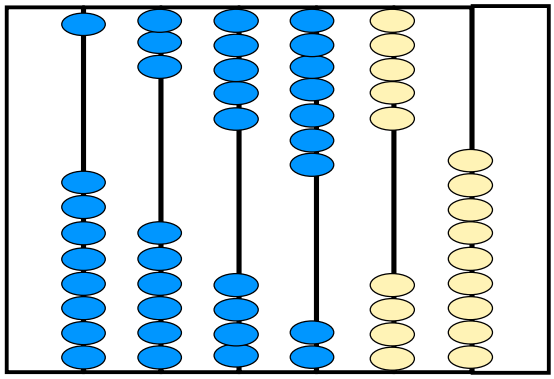
Sample Sounds

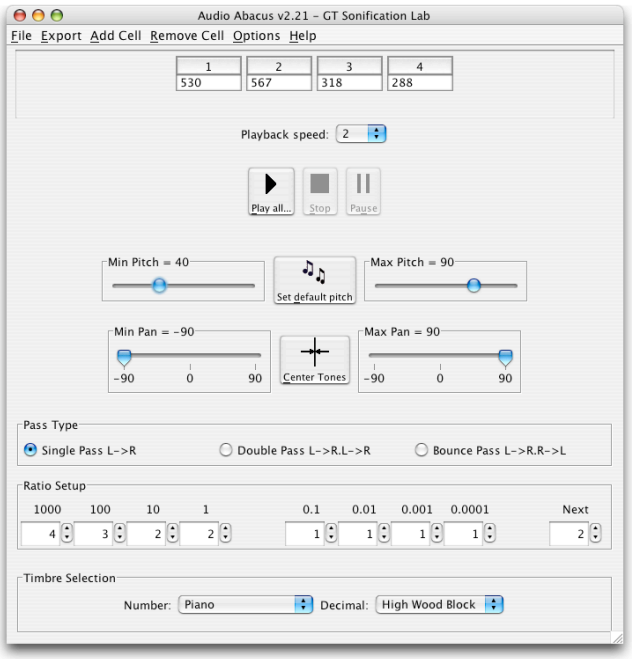
0 0 0 0.0 0



Sample Sounds

1 3 5 7.5 0

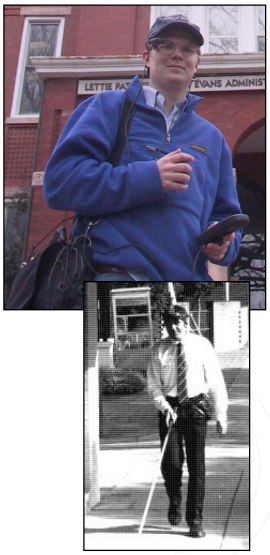




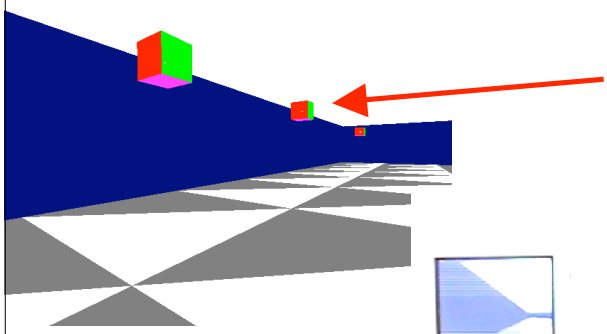
Audio Abacus

The SWAN

- System for Wearable Audio Navigation
  - Wayfinding and navigation
  - Information about the environment
  - Augmented reality
- Localization via sensor fusion
  - GPS, Map Priors, Multi-camera Vision Rig, Compass, InertiaCube
  - Talking Lights, IR, RFID, Thermo, Light level meter, etc.
- Spatialized Audio
  - OpenAL with EAX 3/4 extensions
  - Headtracked



The SWAN VR Test System

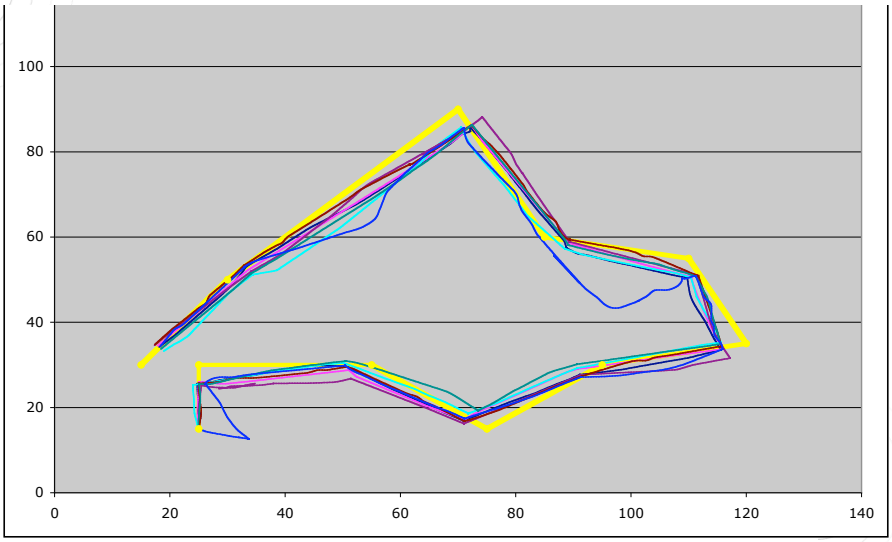


Visual Representation of Audio Beacon

SWAN & Wayfinding

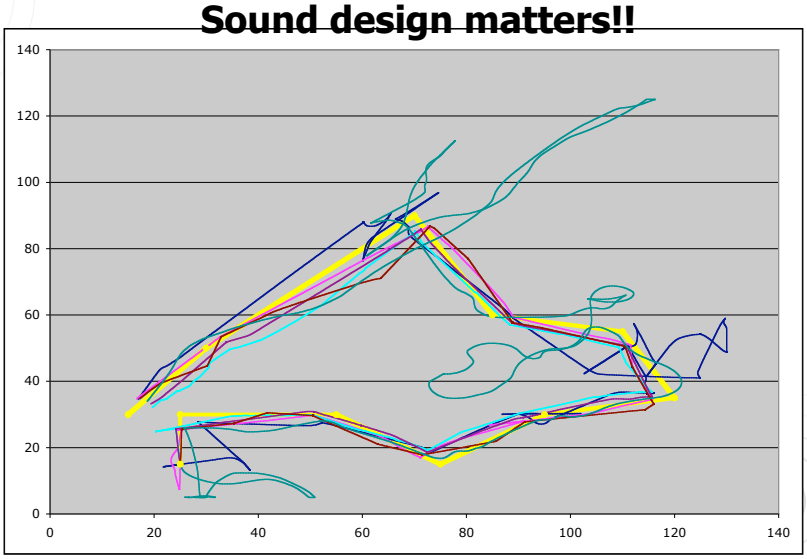
- Wayfinding
  - Focus on beacons - above all, they must be effective
    (and empirically compared to other options)
    - See next slides!

“Good” Beacons



Bad Beacons (!)

Sound design matters!!

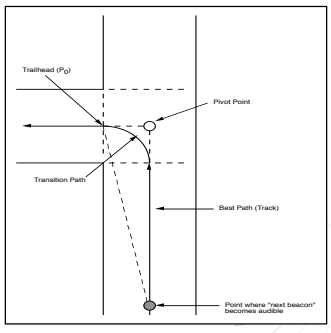


SWAN & Wayfinding

- Wayfinding
  - Focus on beacons - above all, they must be effective
  - Must also be aesthetic (tradeoff with performance?)
    - e.g., different colors of noise, sonar ping

SWAN & Wayfinding

- Wayfinding
  - Focus on beacons - above all, they must be effective
  - Must also be aesthetic (tradeoff with performance?)
  - Provide relevant information
    - e.g., tempo denotes distance
    - e.g., capture radius for smooth transitions to next beacon

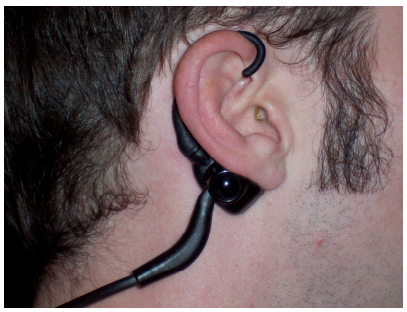


SWAN & Wayfinding

- Wayfinding
  - Focus on beacons - above all, they must be effective
  - Must also be aesthetic (tradeoff with performance?)
  - Provide relevant information
  - Must not impede other tasks
    - Bonephones versus headphones

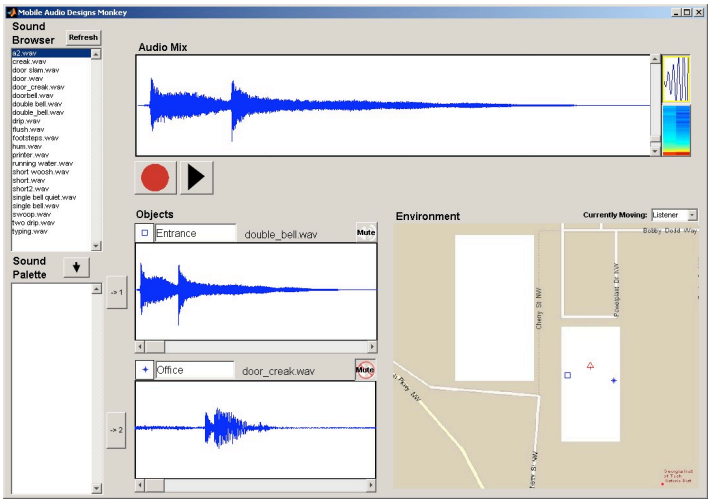
Bone Conduction Headphones

- Full spectrum, do not occlude ears
- Need "Bone Related Transfer Function" (BRTF)
  - (that research is underway :)



Mobile Audio Designs (MAD) Monkey

- Designer's toolkit for mobile audio



Other Projects

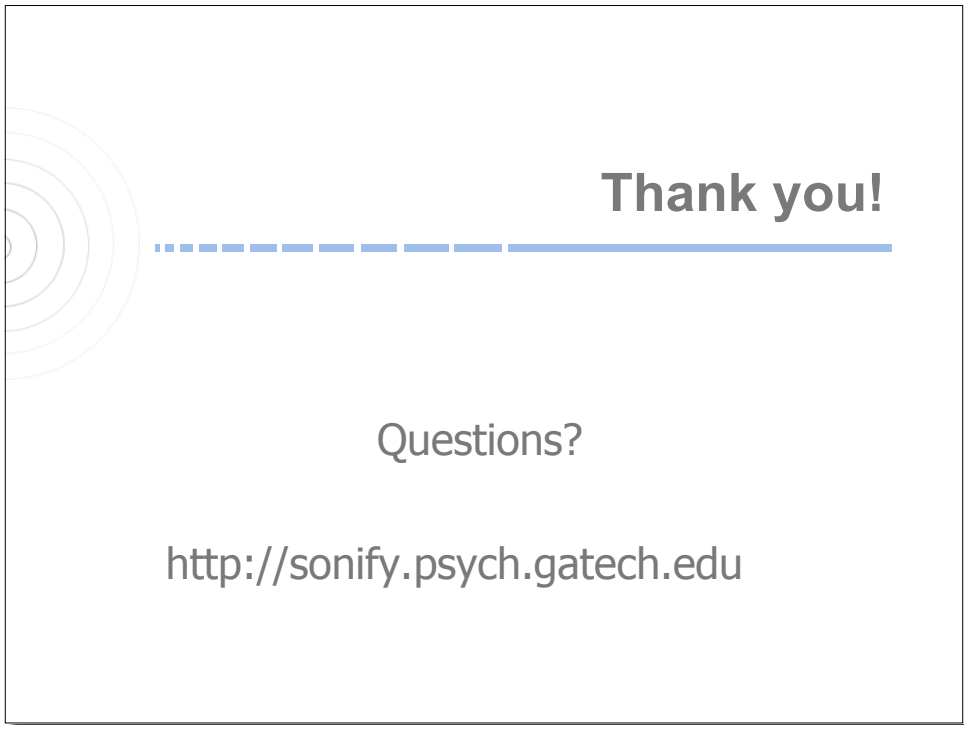
- StockScapes: ambient monitoring displays using nature sounds
- Direct Brain-Computer Interfaces
- Augmented Menus for Mobile Devices
- Eye Tracking & Dialog Boxes
- Talking Braille

Summary

- Perceptual & cognitive aspects of auditory display, sonification, and alternative interfaces
- Implement new applications
- Achieve better performance through evaluation, iteration, and innovation

Opportunities

- Collaboration on science & software
- Exchange / visits
- Grad students


Thank you!
Questions?
http://sonify.psych.gatech.edu