Mapping With Sound

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INTRODUCTION

- this paper is considers **sound as a complement to graphic displays**
    - idea developed several years back when two research projects bumped into each other

1. dissertation literature review on landscape and place geography
    - found literature on the **geography of sound and "soundscape"**
    - **key idea:** importance of non-visual senses in the environment
    - interest in
        - the visual aspects of our environment in relation to cartographic representation
        - sound also important in our environment
            - how does this relate to cartographic representation?

...at the same time...

2. seminar research on animation and multimedia for presentation and visualization
    - researchers interested in representing **more variables** and **time** for research
    - need to develop more **complex cartographic representations**
    - question of how the **sound capabilities** of software/hardware could be used
    - **literature** review uncovered small but growing lit on what has been called
        - sonification, auditory display, and auditory data representation.
        - key idea: **realistic and abstract** uses of sound

- **perspective of this presentation:** cartographic design in the context of animation, visualization, interactivity, hypermedia…
    - other papers in this session
    - as such, a **broad** conception of what mapping and cartography encompasses
    - thus not limited to 2 or 3 dimensional maps in the strict sense of that term
    - interested in solving **cartographic design problems within this broader context**

- **goal of this presentation:** to develop a basic sense of
    - **why** sound may be useful in cartographic displays and
    - **how** sound can be used in cartographic displays
    - and to stimulate some discussion
        - more questions raised than answers offered
        - interested in what people think about using sound in cartography

- structure of presentation

    I. What Exactly is “Mapping With Sound”?

    II. How Can Sound be Incorporated in Cartographic Displays?

    III. Why Use Sound in Cartographic Displays?

I. WHAT EXACTLY IS "MAPPING WITH SOUND"?

• examples which help to **hear** how sound can be used in cartographic displays

• not so great video and sound reproduction

1. VOICE OVER

- important and obvious use of sound
- like text on a map?

2. REALISTIC USE OF SOUND

- first example: Research on forest growth
  - several clips from longer chronological sequence

VIDEO Ex. 1: Sound as a Realistic Cue: Forest fire and windstorm

- relatively intuitive for most people
- how useful is this?
- can text get across the same point?

- issue that sound addresses in this example
  - sound as a redundant variable

• another use of sound…

3. ABSTRACT USE OF SOUND

• two examples: sound as a “cue” and sound “mapped” to data

a. Sound as an **Abstract Cue**

• second example: US Presidential Election landslides

VIDEO Ex. 2: Sound as an Abstract Cue: Reordering of Election Data

• run through four times

1. chronological sequence
   • experience with animation: **more than one thing** happening at a time is **distracting**
   • use sound as an ABSTRACT CUE to replace a distracting visual element
2. chronological sequence with pitch
   • sense that increasing pitch corresponds to increasing years

• other ways to view chronological data: reordering

• **reorder sequence by magnitude of landslide:** lowest to highest

3. reordered sequence

• **if viewer is aware that pitch corresponds to chronological order** then

• **use sound to indicate that the dates have been reordered** – out of order

4. reordered sequence with pitch
   • note **pattern** of “tune” in the sequence
   • sound useful for representing **cyclic chronological data**
   • any **variation** from pattern will be easily noticed
   • better than the visual in this instance?

- **three issues** that sound addresses in this example
    1. problem of **visual distraction** when more than one thing is going on at a time
        - use sound to replace distracting visual elements

    2. problem of **reordered** data when users are not familiar with it
        - use “out of order” sound to indicate that chronological sequence is “out of order”

    3. **sound patterns** versus **visual patterns** in cyclic chronological data

- second example of use of abstract sound

b. Sound “Mapped” to Data: “sound graph”

- third example: AIDS in the United States
  - actual numbers (1980–89) and model predictions (1990–95)

VIDEO Ex. 3: Sound “Mapped” to Data: AIDS in the United States

- run through **three** times

1. chronological sequence

2. chronological sequence with **loudness**
   - **loudness represents total cases for each year**
   - increasing at an increasing rate: can this be heard?
   - adds another variable to the display

3. chronological sequence with **pitch**
   - **pitch represents the percent increase of new cases for each year**
   - very large increases in 1980-82 so eliminate
   - hear the percent increase settle down by late 1980s with anomaly in 1991
   - monitoring or warning capability of sound
     - like fan – sound becomes “invisible” until it changes

- **two** issues that sound addresses in this example

1. adding additional **non-visual data dimension** to display
2. **monitoring** or **alarm** capability of sound

II. HOW SOUND CAN BE INCORPORATED INTO CARTOGRAPHIC DISPLAYS

- the **software** used to create the sounds for this presentation gives you **access to various elements of sound**
    - pitch, amplitude (loudness), etc.

- there is some **intuitive sense** that elements of sound suggest **nominal** or **ordinal properties** and thus may be used and learned in this manner
    - ex) pitch or loudness: high = more, low = less
    - ex) timbre: nominal (qualitative)
    - also register, duration, rate of change, order, attack/decay, silence

- **thus this elemental approach to sound use may provide a useful way to begin thinking about and working with sound**

... and finally...

III. WHY SOUND MAY BE INCORPORATED INTO CARTOGRAPHIC DISPLAYS

- want to avoid **techniques in search of an application**
    - **examples illustrate some potential advantages of using sound in tandem with visual displays**

- **also** justify the use of sound in terms of what can be called…
    - **visualization**: in an abstract sense
        - visualization graphics have a **different** function from presentation graphics
            - presentation graphics attempt to make
                - **immediately intuitive** displays
                - of specific **known "messages"** for users with **general knowledge**

• visualization expands this to also encompass

- **exploratory** uses of graphic displays with no particular "message"
- highly **motivated** and **domain knowledgeable** users
  - Yeung (1980): seven simultaneous sound variables representing seven chemical variables learned relatively rapidly by chemists
- **complex, multivariate, dynamic displays** for such graphic uses and users

• while complexity for complexities sake is silly, there is often the need to display

- multi-variate, temporal data.

  ex) ESSC Paleo Climate Model: 30 variables at each of 12 atmospheric levels
- **cartographers should be able to help with representational problems of this nature**

• **limitations of graphics:** multi-variate maps

- static maps: **two** simultaneous variables seem to be the safe limit
- dynamic maps: sequencing may allow us to expand this to **3 and 4** data variables

• overcome the limitations of graphics with sound?

• forth example: 1990 Census Data

- question: general issue of how where people live and where they work (if they work) and their income level are related

VIDEO Ex. 4: Interactive Map

1. **choropleth map** showing **percent of the population not in the labor force**
    - definite pattern: highs in very rural, depressed areas

2. **graduated circle** map showing **median income**
    - color in circles is redundant; definite pattern which is inversely related to choropleth

- what next?
    - could add third variable as fill for graduated symbols: problems of visual complexity
    - could go to small multiples or a second map: comparison problems
- or can use sound…

3. **pitch in three octaves mapped to drive to work index** (high, medium, low)
    - drive to work index: sense of how far people have to drive to work
    - poorer/low % in workforce rural counties: medium drive to work
    - Pike County: interstate 84 to New York; • Philadelphia >> Montgomery >> Berks
    - **any more or less complicated than adding a third visual variable?**
    - how to design **legends** for this kind of map?

…and another

4. **pitch within each octave mapped to percent poor in each county** (high, med., low)
    - **sequential** sound: drive to work then percent poor
    - pushing it a bit; alternatives to sequence (chords?)

- gets easy to understand and use

CONCLUSION

- I have suggested several basic examples of what mapping with sound can entail
    - voice over
    - realistic sounds
    - abstract sounds
        - sound as a cue
        - sound mapped to data

- I have suggested a basic way in which sound can be incorporated into cartographic displays
    - intuitive sense that elements of sound suggest nominal or ordinal properties and thus may be used and learned – in a heuristic sense – in this manner

- my main goal with this research was to get a basic sense of what sound could be used for and why it might be useful in cartographic displays
    - sound as a **redundant variable**
    - sound as a means of **reducing visual distraction**
    - sound as a **cue to reordered data**
    - **sound patterns** as an alternative to visual patterns in cyclic chronological data
    - sound as an **alarm** or **monitor**
    - sound to add additional **non-visual data dimensions** to complex visual displays

- Finally, I hope this basic introduction provides a useful foundation for debate about the possibilities of sound in cartographic design