

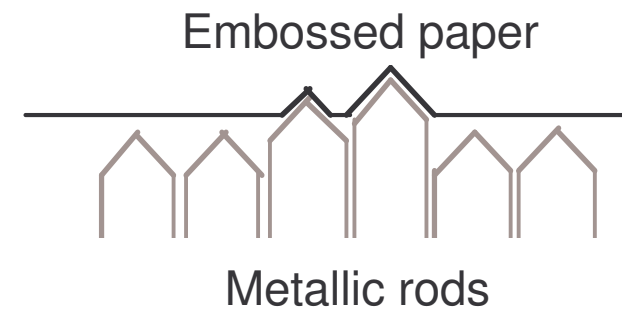
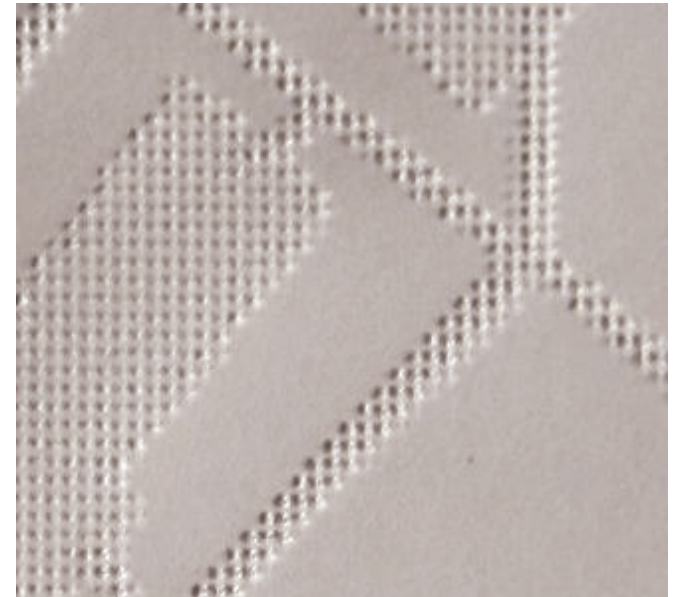
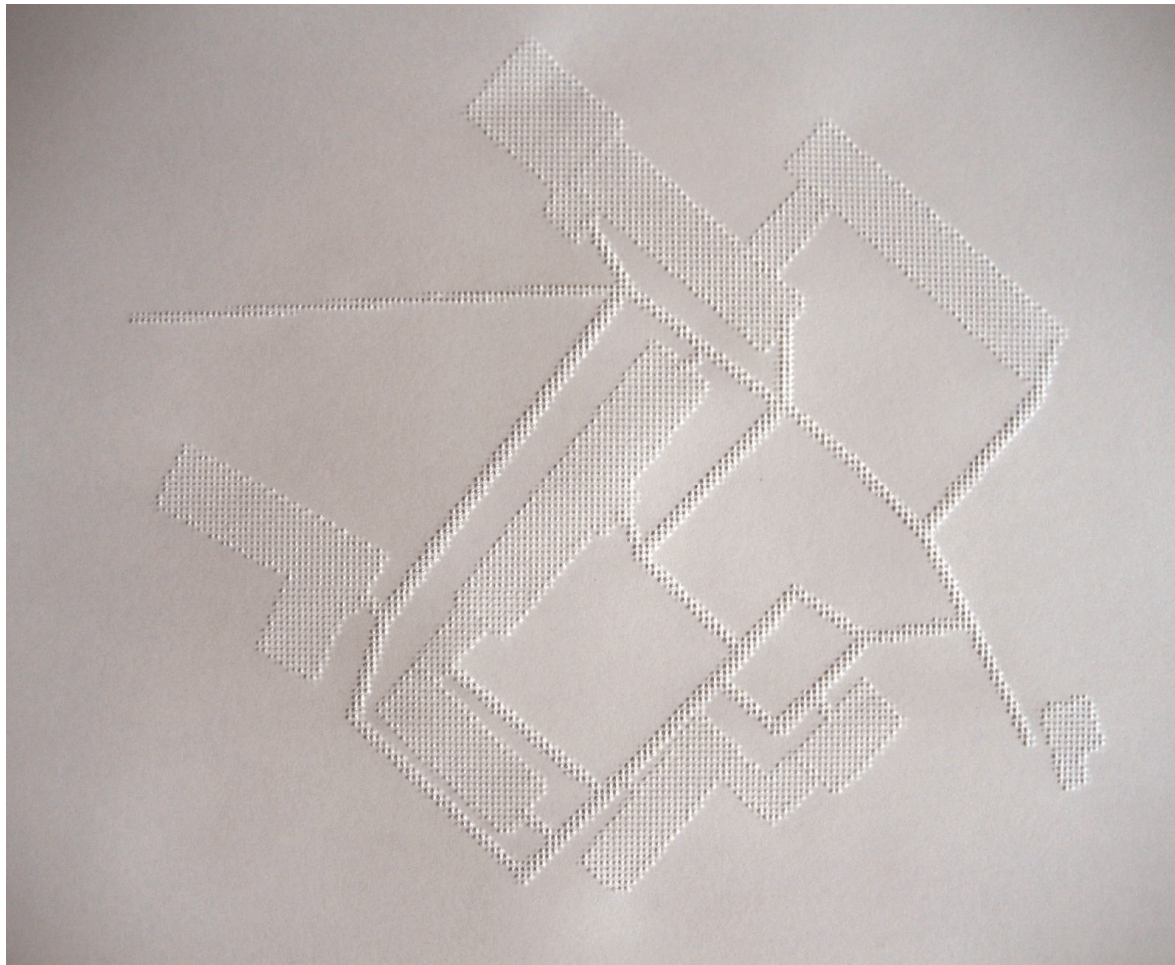
- My Background: Usability Engineering
- Context: Computer-generated tactile maps for communicating spatial knowledge
- Problem: Limits in the usage of tactile maps call for special principles of design
 - Sensory-motor limits
 - Cognitive limits (my focus)

Spatial Information in Tactile Orientation Maps

The Users' Requirements

Christian Graf

Example for a Computer Generated Tactile Map



Tactile Orientation Maps (TOM)



- Map concepts represented by tactually prominent entities
- Pre-trip survey knowledge acquisition
- Problem with tactile maps: Low resolution
- Solution: Schematization
 - Only represent essential concepts
 - Depends on task to be solved, technology available, situational & individual factors

Information Reduction through Abstraction



- Abstracting the topological structure:
 - Omitting nodes
 - Omitting edges
 - Omitting landmarks
- Abstracting the geometrical structure:
 - Straightening lines
 - Limiting intersection angles (4 or 8 sector model)
 - Substitute ecologically valid object signatures with symbols (e.g. area signatures [park, grassland] or point signatures [e.g. houses of different size])

- Identification of *Principles of schematization for the cognitive-plausible construction* of a computer generated tactile orientation map that ease spatial knowledge acquisition/understanding

Interest in This Study



- How to obtain a deliberate choice which information to represent in tactile displays to convey survey knowledge (“Which”)
- How to represent geographic and cartographic concepts in Tactile Orientation Maps to ease survey knowledge acquisition (“How”)

The Fields of GI Science (see Sven's talk) My Work Should Contribute To



	Perception	Cognition	Computation
Effectiveness	■	■	
Efficiency			
Safety			
Utility	■		
Learnability		■	
Memoriability		■	

1. Literature review
2. Interviews with potential and real users of tactile maps
3. Case studies of tactile map usage

Findings of Two Classes



- About Usability Concepts
- About Spatial/Cartographic Concepts

1. Literature Review



- Mostly about sensory requirements: e.g.
 - Berla and Murr (1975) investigated the effects of tactile noise on a tactile map
 - Nolan and Morris (1971) studied minimum sizes for point and area symbols
 - Bentzen and Peck (1979) investigated the traceability of different types of lines
 - McCallum, Ungar, and Jehoel (2006) tested different directional symbols
- Mostly about tactile route maps: Blades, Ungar, Spencer (1999), Renshaw & Zimmerman (2007)

1. Literature Review



- A few about survey maps: Smith (2005), Minatani et al. (2010)
- Very general recommendation (“best practices”): e.g. Edman (1992); Eriksson, Jansson and Strucel (2003); Gardiner and Perkins (2002, 2003)
- No hierarchy in the recommendations makes it hard to apply them in possibly contradictory situation where different forces need to be integrated

Findings 1: Cognitive Factors in Using TOMs



- Topological structure
 - Neighbourhood
 - Connectivity
 - Number of elements
- Geometrical structure
 - Style of lines
 - Type of angles

2. Interviews with of tactile maps



- Late-blind, mobile potential and current users
- Asking about information and usability requirements

- **Cardinal directions**
- **Landmarks**
 - Most important: Persistent, unique objects
 - Important: Public squares, major roads and side streets, pedestrian pathways and intersections, open areas that can be sensed by sound or by smell
- **Scale & Topology**
- **Acoustic Characteristics along Streets**
- **Structural Characteristics at Intersections**

Findings 2.2: Cognitive Needs



- Representations should maintain characteristics of the represented
 - Relative Size
 - Natural Surface properties
- Iconic representations rather than conventional
- Consistency in meaning of symbols over multiple maps

3. Case Studies (in progress at the moment)

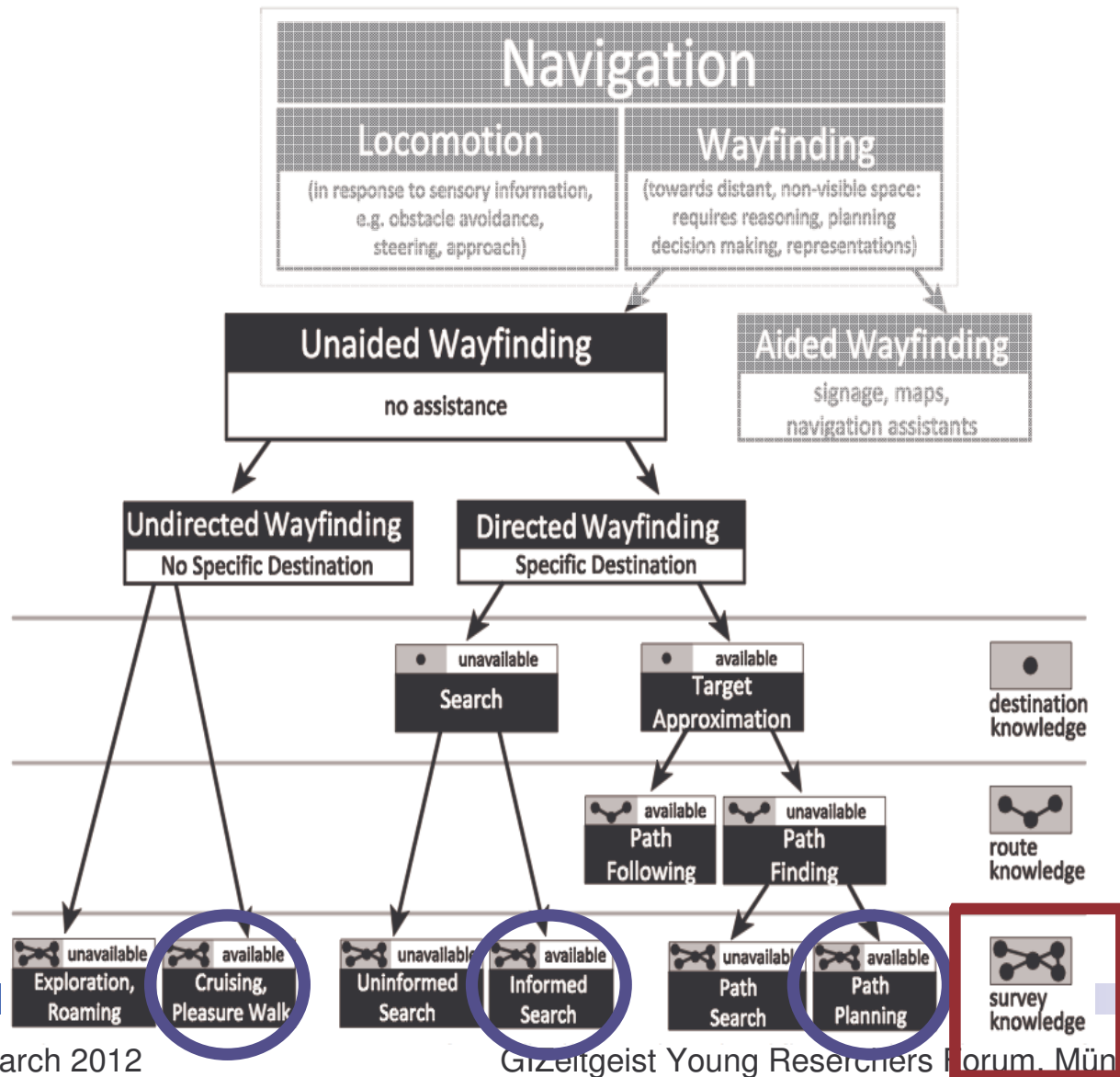


- With blind, mobile people
- Testing their spatial abilities
- Observing the usage of differently constructed tactile orientation maps
 - Different in geometrical factors
 - Different in topological factors
- Testing the acquired spatial knowledge (memoriability)
- Interviews about the usage (effectivity)

- Tactile maps are a challenging field for looking into usability/cognitive factors
- Making tactile orientation maps usable can be understood as contribution to effectivity and learnability
- Requirements for TOM are of two kinds: information orientated & cognition orientated

Additional Slides

Usage of Survey Knowledge in Navigation



Wiener, Büchner, & Hölscher (2009), Fig. 1

- Strube, 1992: Cognitive adequacy (for expert systems)
- Tactile maps are used in a process of knowledge acquisition
- Process of knowledge acquisition should foster adequate mental models
- Concept: *cognitive complexity* to model factors in knowledge acquisition

Proposed Factors/Parameters of Cognitive Complexity

