Tangible E-Learning

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Jennifer Büttgen
LFE Medieninformatik
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Ludwig
Maximilians-
Universität
München
LMU

Giving an Overview:

WHAT ARE ‘TANGIBLES’?

What are ‘Tangibles’?

- New forms of electronically embedded physical artifacts
- That are combined with digital information
- And this way offer a wide range of user interactions and system behavior.

- Tangible User Interfaces are being employed in various application domains
  - E.g.: learning, collaboration, child's play, molecular biology…

See: Dourish, P., 2001. Where the Action Is: The Foundations of Embodied Interaction. Mit Press.

State of the Art

- Lots of frameworks and descriptive taxonomies
- Many different applications
- Enthusiastic notions about various positive effects of tangible systems
- **BUT**: very few research is present that can prove these effects!

Giving an Impression:

EXAMPLES OF TANGIBLES

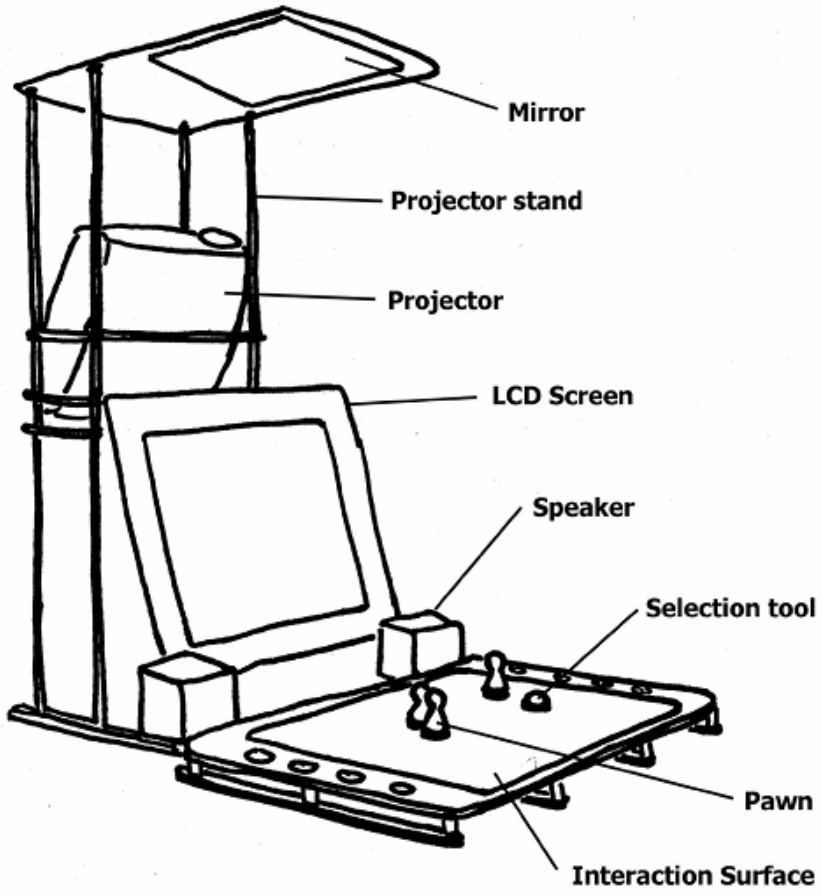
A Cube to Learn

See: L. Terrenghi, M. Kranz, P. Holleis, A. Schmidt . *A cube to learn: a tangible user interface for the design of a learning appliance*. Personal and Ubiquitous Computing, 2006, Springer

KidPad for Storytelling

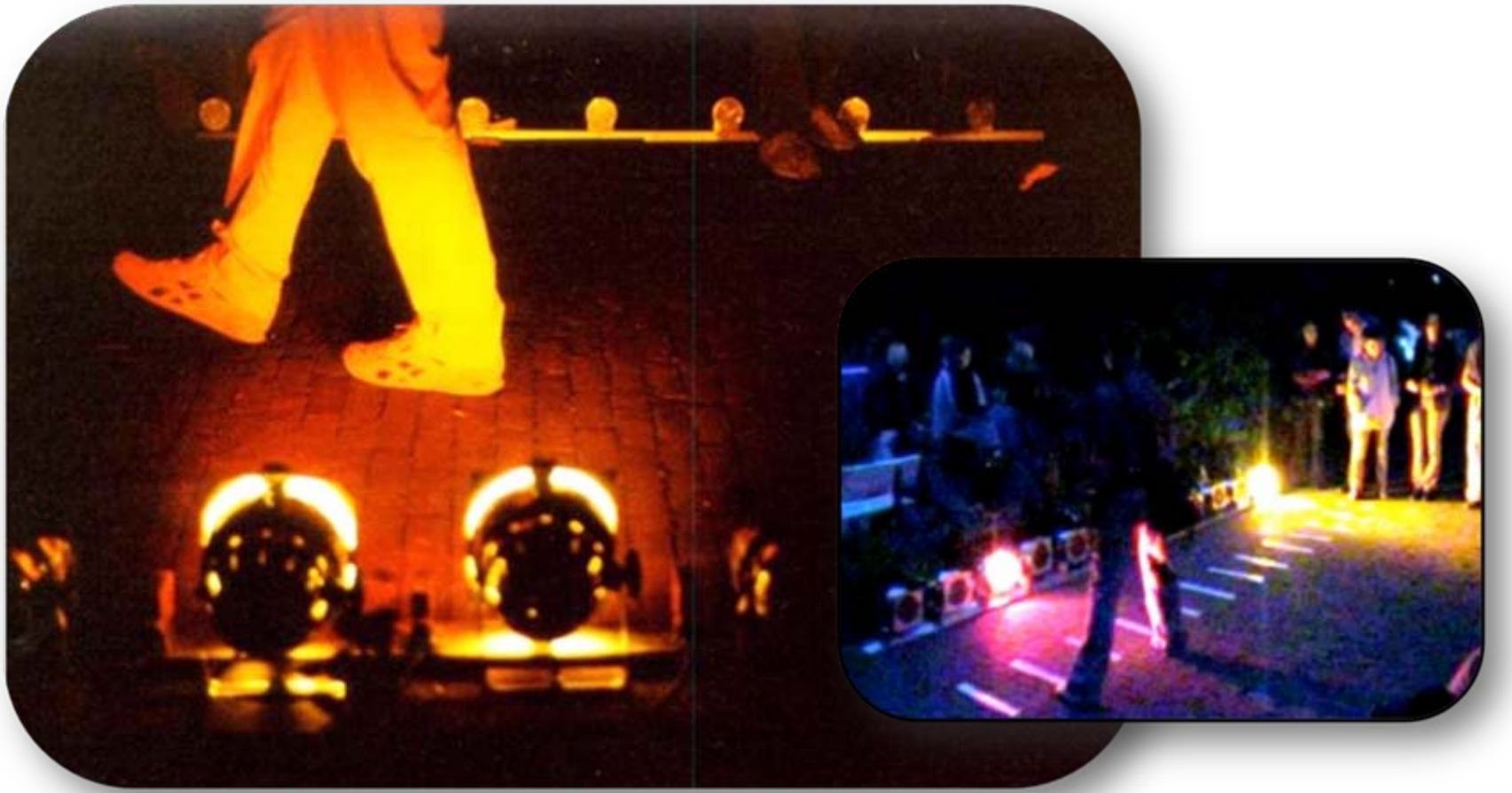
See: Stanton et al.: *Classroom collaboration in the design of tangible interfaces for storytelling*. In: Proceedings of the SIGCHI conference on Human factors in computing systems, CHI, p. 482–489, 2001, ACM.

Tangible Viewpoints



See: A. Mazalek, G. Davenport, H. Ishii: *Tangible viewpoints: a physical approach to multimedia stories*. In: Proceedings of the tenth ACM international conference on Multimedia, p.153–160, 2002, ACM.

The CLAVIER



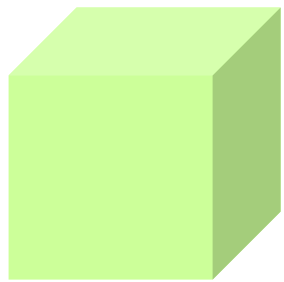
See: E. Hornecker, J. Buur: *Getting a grip on tangible interaction: a framework on physical space and social interaction*. In: Proceedings of the SIGCHI conference on Human Factors in computing systems, CHI, p. 437–446, 2006, ACM.

Strengths and Weaknesses of Tangibles seen as Physical Media.

TANGIBLES AS PHYSICAL MEDIA

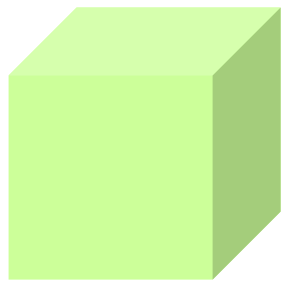
Strengths of Physical Media

- Direct, naive and intuitive understanding and manipulation
  - Because the interaction with physical objects is a natural action
- Additional tactile sensation
- Physical objects are closer to reality
  - can be moved and placed within a 3D space



Weaknesses of Physical Media

- Alternative realities are hard to construct
  - Users are restrained by the rules of the physical world!
- Passiveness of objects
  - Unless initiated by the user, objects cannot change their representation
- Difficult management and storage of information



Combining physical and computational media

- Some of the physical shortcomings can be overcome by an integration with computational media.
- BUT:
  - Computers are „inside the box“ and „have to be worked“
  - The decentralized control that is supported in physical environments often expires when using computers!

See: Arias, E., Eden, H., Fisher, G., 1997. Enhancing communication, facilitating shared understanding, and creating better artifacts by integrating physical and computational media for design. In: DIS ’97: Proceedings of the 2nd conference on Designing interactive systems. ACM, NY, USA, pp.1–12.

Comparing different interfaces:

TANGIBLE VERSUS TRADITIONAL AND DESKTOP ENVIRONMENTS

Tangible versus Traditional and Desktop Environments

- A study from Xie et al. compared children's interaction with a jigsaw puzzle in different environments:
  - Traditional / Physical User Interface (PUI)
  - Desktop / Graphical User Interface (GUI)
  - Tangible User Interface (TUI)

See: Xie, L., Antle, A. N., Motamedi, N., 2008. *Are tangibles more fun?: comparing children's enjoyment and engagement using physical, graphical and tangible user interfaces*. In: TEI '08: Proceedings of the 2nd international conference on Tangible and embedded interaction. ACM, USA, pp. 191–198.

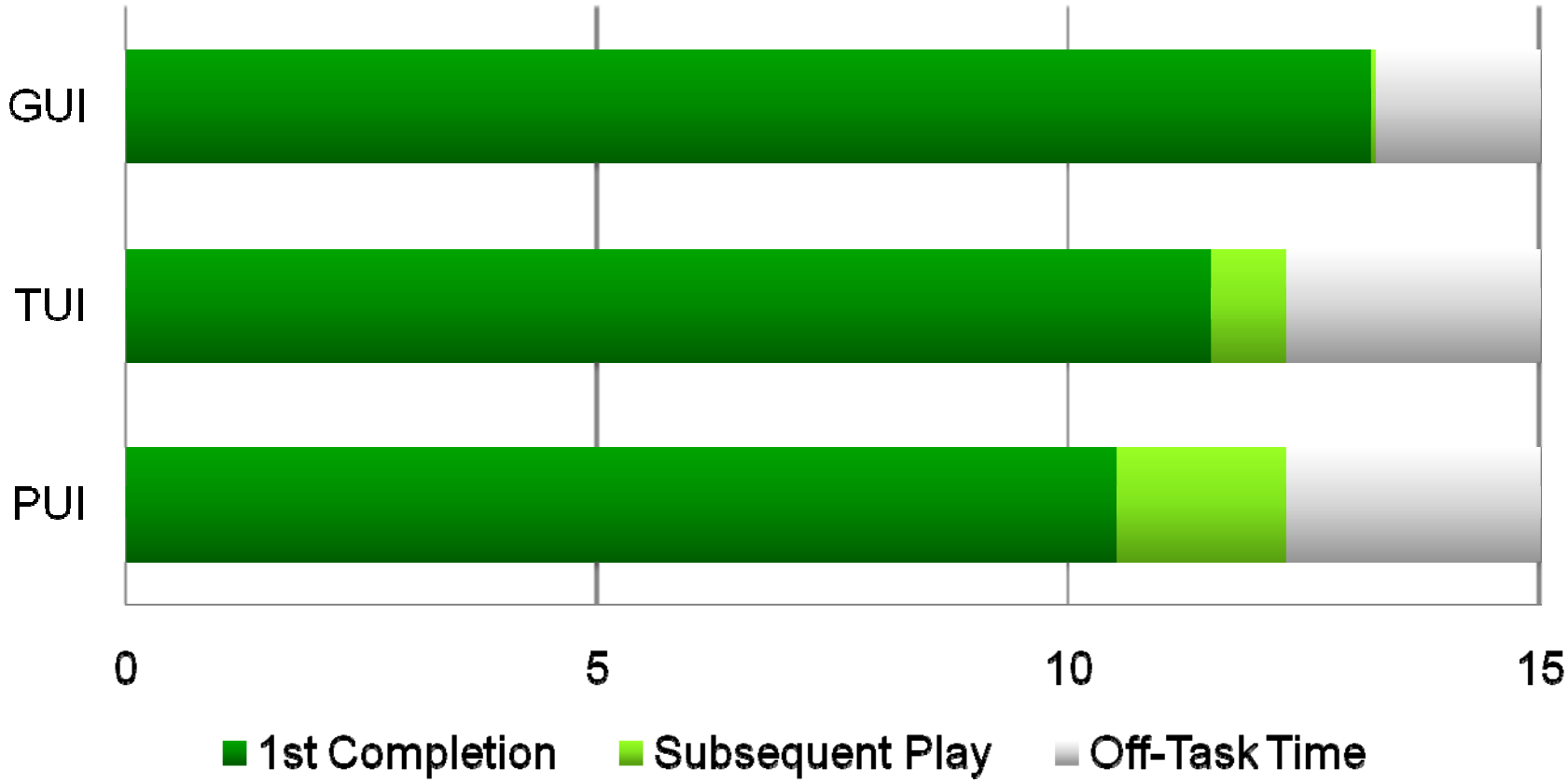
In PUI and TUI condition:

- Help was less needed in PUI and TUI
- Parallel but independent interaction
- Still the children kept an eye on the actions of their partner
- Children showed much more interest and activity in PUI and TUI condition:
  - *Body movement*: moved themselves around the table instead of the puzzle
  - *Change of perspective*: children solved the puzzle upside down.
  - Such body movement or changing of perspective wasn't practicable in the GUI!

In the GUI condition:

- Indirect interaction using a mouse or touchpad was difficult and frustrating
- Less communication between the children in GUI condition
- Parallel play is difficult due to the existence of only one single input device
  - *Off-Task-Time*: was higher when children did not have control of an input device
  - Four primary reasons were found for Off-Task-Behavior:
    - Boredom
    - Frustration
    - Distracting events
    - Observing the others

Jigsaw play times for different UIs



Modified from: Xie, L., Antle, A. N., Motamedi, N., 2008. *Are tangibles more fun?: comparing children's enjoyment and engagement using physical, graphical and tangible user interfaces*. In: TEI '08: Proceedings of the 2nd international conference on Tangible and embedded interaction. ACM, New York, NY, USA, pp. 191–198.

Gender Differences

- *Level of interest*:
  - Both genders showed greater interest in the PUI
  - Boys in general were more captivated in the GUI than girls
- *Level of competence*:
  - Girls were more competent in the PUI than in the GUI/TUI
  - Boys were more competent in the GUI than girls
- *Level of interaction*:
  - Boys tended to point and touch more in all environments

Additional Findings from other Studies:

COLLABORATION AND ITS REQUIREMENTS

Encouraging Collaboration, Motivation and Engagement

- Various user studies found evidence for an increased amount of…
  - Collaboration
  - Motivation
  - Engagement
  - Excitement
  - Comprehension
  - Retention
  - Activity and Body Movement
  - Immersion in the activity.

See e.g.: Inkpen et al., 1999; Price et al., 2003; Stanton et al., 2001; Xie et al., 2008; Fails et al., 2005; Marshall et al., 2003, Marshall et al., 2007; Arias et al., 1997; Chipman et al., 2006

Requirements and Guidelines for collaborative Learning

- It is not enough for a system to just be tangible!

- Physical size and tokens
  - Interaction with larger objects is slower and therefore easier to follow by others.
  - If each user has control of a token, multiple users can interact simultaneously.

- Certain superficial appearances may provoke distinct physical interactions
  - Example: Kidpad (Stanton et al., 2001) employed sensors on a carpet:
  - *Rectangles:* → children jumped on them heavily.
  - *Arrows:* → carefully placed one foot on the sensors.

See: Stanton et al., 2001. Classroom collaboration in the design of tangible interfaces for storytelling. In: CHI '01: Proceedings of the SIGCHI conference on Human factors in computing systems. ACM, NY, USA, pp. 482–489.

CONCLUSION

Conclusion

- Several studies found evidence for positive effects of tangibles

- BUT:
  - There still is a lack of sufficient empirical research about the *how* and *why*!
  - Investigators are often in danger of being too enthusiastic
  - More detailed guidelines for the designers of tangibles have to be evolved.

- Nevertheless: If developed further, future tangible systems certainly can facilitate collaborative work and learning significantly!
- Example: KidPad (Stanton et al., 2001): already used in Englisch Schools!

Thank you for your Attention!

QUESTIONS?

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