Game Design - Tangible Media -

Prof. Dr. Andreas Schrader ISNM International School of New Media University of Lübeck Willy-Brandt-Allee 31a 23554 Lübeck Germany schrader@isnm.de



MIT Media Laboratory, Boston



We live between two worlds: our physical environment and digital space. The Tangible Media Group at the MIT Media Lab focuses on the seamless couplings between physicality and virtuality.

Hiroshi Ishii at PERVASIVE'2004

- Ishii founded and directs the Tangible Media Group
- Goal: Changing from ,*painted bits*⁴ of GUIs to ,*tangible bits*⁴ to enable new forms of HCI
- Giving physical form to digital information

6/8/2004

- Both scientific and artistic aspects are handled at the MIT
- Reseach results have been demonstrated at scientific conferences and art exhibitions

Source: tangible.media.mit.edu/index.html



- Traditional Graphical User Interfaces (GUI) do not employ many of the human skills for sensing and manipulating the physical environment
- Ishii's Tangible Bits try to use these skills in better ways to use physical interaction pattern for the digital space
- Tangible User Interfaces include physical objects, surfaces and spaces

Foreground Interactions

 exploit the human sense of touch and kinesthesia by using graspable objects and augmented surfaces

Background information displays

 use "ambient media" - ambient light, sound, airflow, and water movement at the periphery of human awareness





drawing: Hiroshi Ishii



Source: tangible.media.mit.edu/projects/Tangible_Bits/projects.htm



INTERNATIONAL SCHOOL OF NEW MEDIA

Game Design

- Three early research platforms are tangible user interfaces
 - metaDesk Tangible Desk
 - transBoard Tangible Wall
 - ambientRoom Tangible Room

metaDesk

- Horizontal backprojected graphical surface
- An arm-mounted LCD screen (,active lens')
- Optically transparent lens (,passive lens')
- "phicons" physical icons are sensed by an array of optical, mechanical and electromagnetic field sensors



Hiroshi Ishii and Brygg Ullmer

Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms CHI 97, ACM Conference on Human Factors in Computing systems, Atlanta, Georgia USA 22-27 March 1997



INTERNATIONAL SCHOOL OF NEW MEDIA





transBOARD

ambientROOM

TUI: Tangible UI	(PD) lens	phicon	tray	phandle	(FEF EFF instrument
GUI: Graphical UI	window	icon	menu	handle	widget

Physical instantiation of GUI elements in TUI

Game Design

metaDESK

□ metaDesk Example: GeoSpace

 Tangible Geospace uses physical models of landmarks such as MIT's Great Dome and Media Lab buildings as phicons to allow the user to manipulate 2D and 3D graphical maps of the MIT campus



Hiroshi Ishii and Brygg Ullmer

Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms

CHI 97, ACM Conference on Human Factors in Computing systems, Atlanta, Georgia USA 22-27 March 1997



INTERNATIONAL SCHOOL OF NEW MEDIA



Fullfilling the vision of Weiser, the world itself becomes the interface
Key concepts:

Interactive Surfaces

 Transformation of each surface within architectural space (e.g., walls, desktops,ceilings, doors, windows) into an active interface between the physical and virtual worlds;

Coupling of Bits and Atoms

- Seamless coupling of everyday graspable objects (e.g., cards, books, models) with the digital information that pertains to them; and
- Ambient Media
 - Use of ambient media such as sound, light, airflow, and water movement for background interfaces with cyberspace at the periphery of human perception.
- □ Strategy: not embedding GUI metaphor in pervasive devices, but instead augment existing physical devices with digital technology



Hiroshi Ishii and Brygg Ullmer

Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms CHI 97, ACM Conference on Human Factors in Computing systems, Atlanta, Georgia USA 22-27 March 1997



INTERNATIONAL SCHOOL OF NEW MEDIA

6/8/2004

□ Example: SuperCiliaSkin

- Multi-modal interactive interface, conceived as a computationally enhanced membrane coupling tactile-kinesthetic input with tactile and visual output.
- Inspired by the beauty of grass moving in the wind
- An array of individual actuators (cilia) use changes in orientation to display images or physical gestures as physical or tactile information.
- Tactile/kinesthetic activity involves the two hemispheres of the brain simultaneously and increases the learning experience (long term memory)



Source: http://tangible.media.mit.edu/projects/Super_Cilia_Skin/Super_Cilia_Skin.htm

6/8/2004









Example: SuperCiliaSkin

- How does it work?
 - Actuators arranged in an array have a cotton felt tipped rod
 - A magnet at the base is fixed with plastic nods
 - Displacement is realized through magnetic forces below the surface
 - After deformation, the elasticity of the membrane forces an oscillation back to the original position
 - Also input device functionalities are planned



Actuator with magnetic base

6/8/2004

Array of actuators



Raffle, H., Joachim, M., Tichenor, J., Super Cilia Skin: An Interactive Membrane, in *Extended Abstracts of Conference on Human Factors in Computing Systems (CHI '03)*, Fort Lauderdale, Florida, USA, April 5- April 10, 2003



INTERNATIONAL SCHOOL OF NEW MEDIA

Game Design

□ Example: Actuated Workbench

 A device to scan objects on a table and to force objects moves through magnetic forces in two dimensions







Pangaro, G., Maynes-Aminzade, D., Ishii, H. The Actuated Workbench: Computer-Controlled Actuation in Tabletop Tangible Interfaces, in *Proceedings of Symposium on User Interface Software and Technology (UIST '02)*, Paris, France, October 27 - 30, 2002

INTERNATIONAL SCHOOL OF NEW MEDIA

ISNM

6/8/2004

Game Design

Example: InTouch

- Current system for real-time distributed CSCW mainly use GUI software or video conference systems
- InTouch provides a device for haptic interpersonal communication



Tangible User Interface

Realtime distributed CSCW based on tangible User Interfaces

InTouch consists of two hand-sized objects with cylindrical rollers



Source: tangible.media.mit.edu/projects/inTouch/inTouch.htm



□ Example: *InTouch*

- Remote users can feel the local movements and vice versa
- Position sensors and high precision motors allow for bilateral forcefeedback providing a means for expressions through touch
- More than 500 people have tried inTouch in a study
- Result: InTouch provides a means to be aware of a distant person's emotional state and sincerity
- Information exchange nevertheless is limited









ISNM

Source: Brave, S., Dahley, A., Frei, P., Su, V., and Ishii, H., inTouch, in *Conference Abstracts and Applications of SIGGRAPH '98*, Enhanced Realities, Orlando, Florida USA, July 19-24, 1998

6/8/2004



□ Example: SandScape

- Yao Wang, Assaf Biderman, Ben Piper, Carlo Ratti, and Hiroshi Ishii
- SandScape is a tangible interface for designing and understanding landscapes through a variety of computational simulations using sand
- Simulations are projected on the surface of sand
- A variety of different simulations highlight either the height, slope, contours, shadows, drainage or other aspects of the landscape model
- The users can alter the form of the landscape model by manipulating sand while seeing the resultant effects of computational analysis generated and projected on the surface of sand in real-time







Source: tangible.media.mit.edu/projects/SandScape/SandScape.htm



Game Design

Source:

Piper, B., Ratti, C., Ishii, H. Illuminating Clay: A Tangible Interface with Potential GRASS Applications, in Proceedings of the Open Source GIS - GRASS User's Conference 2002 (Trento, Italy, Sep. 11-13, 2002)

Tangible Media

Any material (clay, paper, wood, sand) Cost: ~ 45.000 €

Example: SandScape

Version 2

INTERNATIONAL SCHOOL OF NEW MEDIA

Version 1

Clay

Sand (specialized glass beads of 0.5mm diameter)

40.000 elevation points of high accuracy within a second

Infrared light source from underneath

6/8/2004

Monochrome infrared camera mounted above

Using a Minolta Vivid 9002 laser scanner

- Less depth more light, more depth less light
- Cost: ~ 500 €
- But accuracy quite limited







□ Example: **SandScape**

- The scanned surface of the physical model can be modeled using landscape analysis functions
- The results of the functions can be projected back onto the surface
- Different color maps can be used for different aspects
- Example: water flows in landscapes
- Almost realtime experiences
- Geo-science professors can teach their students, etc.





Piper, B., Ratti, C., Ishii, H. Illuminating Clay: A Tangible Interface with Potential GRASS Applications, in Proceedings of the Open Source GIS - GRASS User's Conference 2002 (Trento, Italy, Sep. 11-13, 2002)

height values



INTERNATIONAL SCHOOL OF NEW MEDIA

6/8/2004

Game Design



Local Drain Direction

□ Example: *MusicBottles*

- A minimal interface using bottles as containers and controls
- Bottles are both tangible and visual
- A transparent interface that weaves seamlessly into the fabric of everyday life
- The first idea was to use a single bottle for weather forecast information

(Ishii wanted to support his mother with a nice tool, he stated in PERVASIVE'2004)





Hiroshi Ishii, Ali Mazalek, Jay Lee, Bottles as a Minimal Interface to Access Digital Information (short paper), in *Extended Abstracts of Conference on Human Factors in Computing Systems (CHI'01),* Seattle, Washington, USA, March 31 - April 5, 2001, ACM Press, pp.187-188

Game Design

□ Example: *MusicBottles*

- Small electromagnetic resonator tags are placed around the opening of bottles
- Pieces of ferrite are embedded in the corks
- A custom-designed tag reader board is sensing the resonant frequencies
- A computer is connected via a serial port and generates audio output



tag reader





colored light sources

6/8/2004

speaker

Example: MusicBottles

- The concept was later extended with several bottles
- Each bottle stands for one musical instrument in a song
- The bottle metaphor is used for controlling the music
- The exhibition was an art concept, but there are also applications, e.g. medical bottles could remind patients of prescriptions and medications





Video at http://tangible.media.mit.edu/projects/musicBottles/mpeg_hires.mov

Source: tangible.media.mit.edu/projects/musicBottles/musicBottles.htm



□ Example: *AudioPad*

- A composition and performance instrument for electronic music
- Positions of objects on a tabletop surface are tracked and converted into control commands for music synthesizers
- Visual feedback is projected with a beamer on the table
- Allows for new visual and tactile dialogues between performers, the audience and the system itself



Source: tangible.media.mit.edu/projects/Audiopad/Audiopad.htm

6/8/2004



□ Example: *AudioPad*

- Usually MIDI controllers with knobs and sliders are used for music creation
- The Kork Kaoss Pad allows for recording complex finger movement on a pad for music control
- Alesis Air FX allows 3-dimensional movements in the air to control DSP processing of sound (infrared controlled)
- Both are limited to the inbuilt design
- The MIT AudioPad can be adjusted to any music system, since there is no fixed hardware setting
- Arbitrary parameter controls can be projected





Kork Kaoss Pad II

Alesis Air FX



Source: http://www.kaoss.co.uk/, http://www.alesis.com/products/airfx/airfx_front.jpg



6/8/2004

Example: AudioPad

- Object positions are scanned using passive RF tags
- The amplitude of the resonance is measured (each object uses a different frequency)
- Two LC tags per object to determine position and orientation
- Measurement accuracy: 4mm



RF Tag in Audiopad objects



Patten, J., Recht, B., Ishii, H., Audiopad: A Tag-based Interface for Musical Performance, in *Proceedings of Conference on New Interface for Musical Expression (NIME '02)*, Dublin, Ireland, May 24 - 26, 2002



INTERNATIONAL SCHOOL OF NEW MEDIA



Example: ReacTable

- Music Technology Group, Audiovisual Institute, University Pompeu Fabra in Barcelona, Spain
- Camera controlled surface tracks object movements for music control





S. Jordá, Sonigraphical Instruments: From FMOL to the reacTable*,

In Proceedings of 2003 International Conference on New Interfaces for Musical Expression, Montreal, Canada, 2003.

Source: http://www.iua.upf.es/mtg/reacTable/



Exhibition ICC Tokyo, 2000 (tangible.media.mit.edu/projects/ICC_Exhibition)

6/8/2004





Game Design

Example: BlockJam

- Sony Interaction Laboratory (2002)
- Block Jam is a musical interface controlled by 25 tangible blocks
- Musical phrases and sequences are created by block arrangements
- Each block has a visual display and a combination of a gestural input and a click-able input
- Each Block metaphorically contains a sound group that can be chosen via the gestural input
- The click-able input changes a block functionally



Source: http://www.csl.sony.co.jp/IL/projects/blockjam/



Example: Jam-O-Drum / CircleMaze

- Tina Blaine, Clifton Forlines (Independent Artists, former Carnegie Mellon)
- An interactive musical multi-player game
- Each player has a turntable input device
- Goal: direct the game pieces into the middle of the labyrinth



Source: http://www.aec.at/en/center/project.asp?iProjectID=11194





Example: Jam-O-Drum / CircleMaze

- Maze is divided into concentric rings, the peaces must pass through each ring
- Formation of teams is required, since the goal can only reached by cooperation
- Successful collaboration also modifies the musical arrangement



Source: http://www.aec.at/en/center/project.asp?iProjectID=11194



□ Example: *Tug of War*

- Peter Higgins, Joachim Smetschka, Gerfried Stocker (AEC)
- Built for the Playscape Zone of Milleniums Dome, London, 2000
- Goal: pulling a rope against virtual opponents
- First the player is asked to pull the rope as hard as possible so that the computer can choose his opponent. Then the game starts. The object is to pull as many opponents off the screen as possible in two minutes





Source: http://www.aec.at/en/center/project.asp?iProjectID=11194



□ If you want to play yourself:

 Tangible Media projects are shown at the "Get in Touch" exhibition at the Ars Electronica Center in Linz, Austria since September 2002

(http://www.aec.at/en/center/)

6/8/2004













INTERNATIONAL SCHOOL OF NEW MEDIA