# Tangible User Interfaces

Seminar Vernetzte Systeme

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# Outline

Introduction

ToolStone
- Motivation
- Design
- Interaction Techniques

Taxonomy for Tangible User Interfaces
- Examples
- The 2-D Tangibility Space
- TUI examples in the Taxonomy

Conclusions

# Introduction

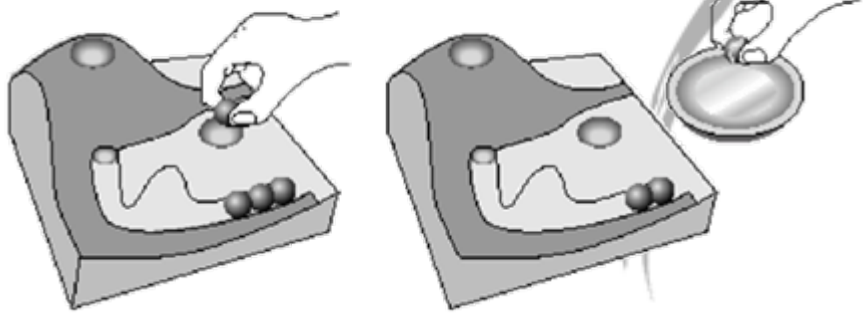
- Tangible, graspable, physical, embodied and others.
- Tangible is the most broadly accepted expression. (Personal and Ubiquitous Computing Magazine: Introduction)

"The use of physical objects as manipulability representations of information."

# Key Influences

Tangible user interfaces (TUIs) have been a very active topic in human-computer interaction for much of the last decade.

- Ubiquitous computing
- Augmented reality
- Bishop's 1992 Marble Answering Machine.



# Taking Advantage of TUIs

- They can intuitively be used by non professionals.
- TUIs dramatically extend the design space of traditional GUIs.
  - Shape, size, color, weight, smell, texture...
- Make use of a human's rich manipulation skills.
  - Chunks of physical operations.

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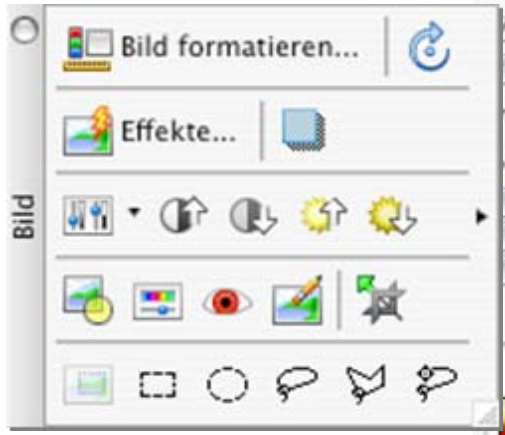
# To Handle Complex Software

- Complexity of software increases.
- Many tool bars, scroll bars, pop-up menus or tool palettes.
  - Selection requires physical and visual efforts.
  - Every tool takes up screen space.
  - Bigger screens require more time-consuming mouse movements.



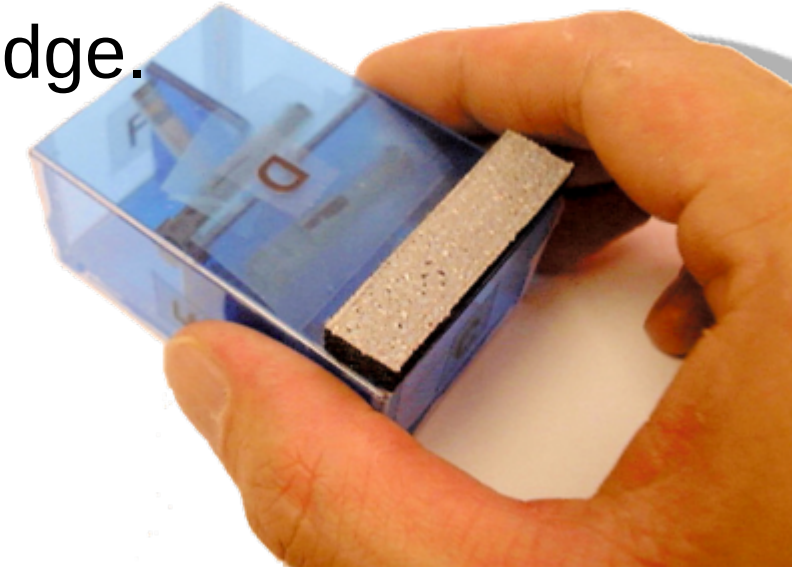

# Free Your Screen and the Rest Will Follow

- Make use of the non-dominant hand.
- Physical tools allow use of a human's rich manipulation skills.
  - Chunks of physical operation.
  - Select a tool by the way the user holds the device.

  ➔ Rich-Action Input (RAI)
- Visual Attention is not required.
- Mouse movements are minimized.

# An Effective Input Device: ToolStone

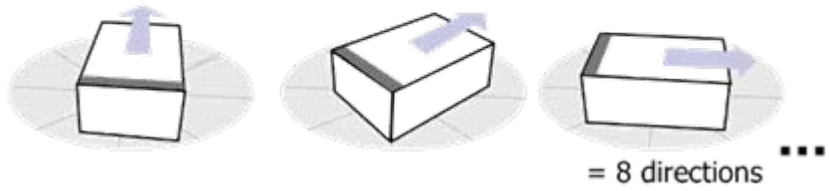
- Jun Rekimoto.
- Semi-6DOF input device.
  - Detect x-y position, orientation and touching face (tilting).
- Perceive orientation by touch.
  - Small bar at one lower edge.
  - Width, height, depth are all different.
- Device for the non-dominant hand in bimanual interfaces.



# Interaction Techniques

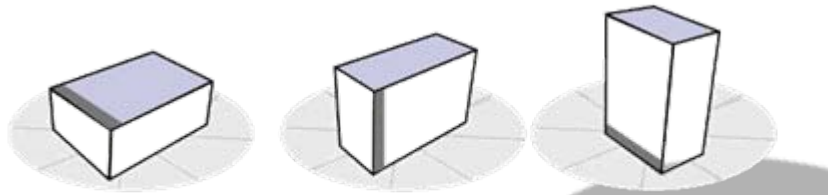
- Directions separated by 45 degrees.

➔ 8 tool palettes




- Flipping the stone.

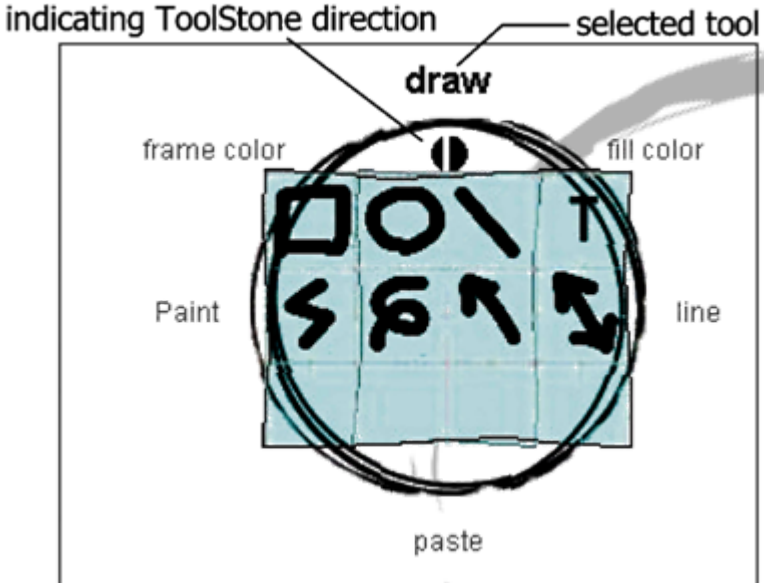
➔ 6 different set of tools



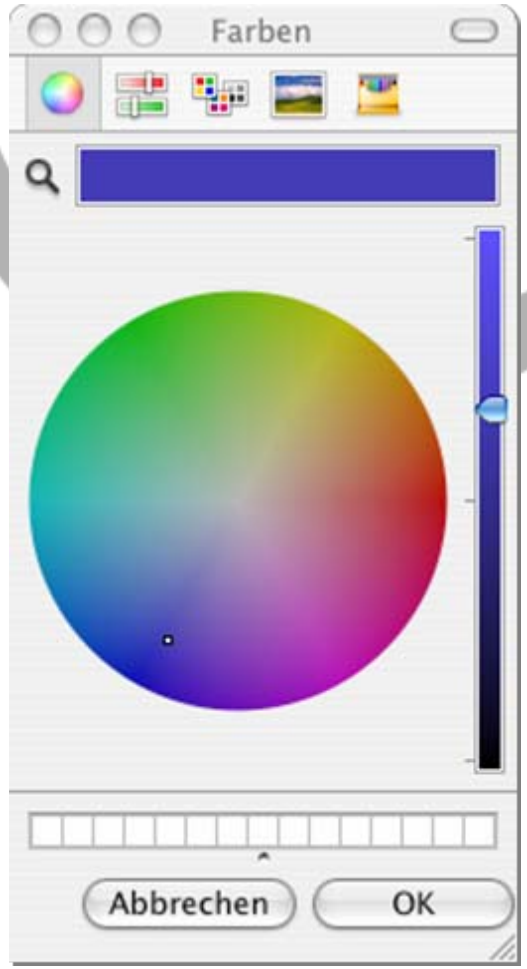

- $8 \times 6 = 48$ different tool palettes selectable by physical action.

# Visual Supply

- ToolGlass like functionality.
  - Move tool palette in order to minimize mouse movements.
- Labels around the tool palette indicate available functions attached to the same face.
- Labels printed on ToolStone for novice users.



# More Interaction Techniques




Some interactions need to control parameters with a dimension < 2.

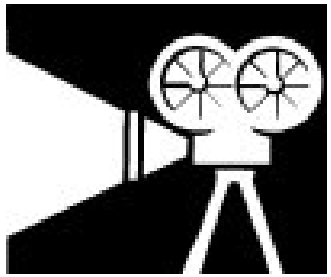
E.g. color space (hue-saturation-brightness)

Existing tools often force unintuitive operations because of the bad mapping of the parameters to the 2-D tool palette space.

# More Interaction Techniques

- Select color space.
  - Manipulate brightness with ToolStone.
- Zooming and panning of the workspace.
  - Rotate to zoom move to scroll.
- 3-D rotation of an object.
  - Move to change rotation axis.
- Virtual camera control.
  - Dominant hand device available to change parameters.

# Demo Movie



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- **Taxonomy for Tangible User Interfaces**
  - Examples
  - The 2-D Tangibility Space
  - TUI examples in the Taxonomy
- Conclusions

# A Taxonomy to Analyze Tangible Interfaces

- Kenneth P. Fishkin

  TUIs have been largely an “I know one when I see one” field.

- This work proceeds beyond “proof of concept” examples.

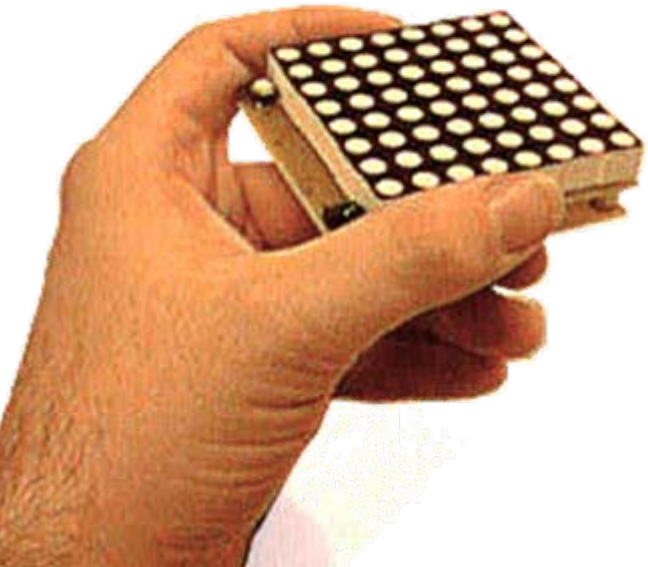
  ➔ Provide a framework to compare works in the space.

# Three Examples of TUIs - No1

- “The Great Dome” - Ishii & Ullmer (1997)
  - Augmented desktop displays a map.
  - Map changes the view accordingly to the movements of a model of the MIT Great Dome building on the desktop.

# Three Examples of TUIs - No2

- “Shakepad” - Levin & Yarin (1999)
  - Key chain computer based device.

•Display can be cleared by shaking.

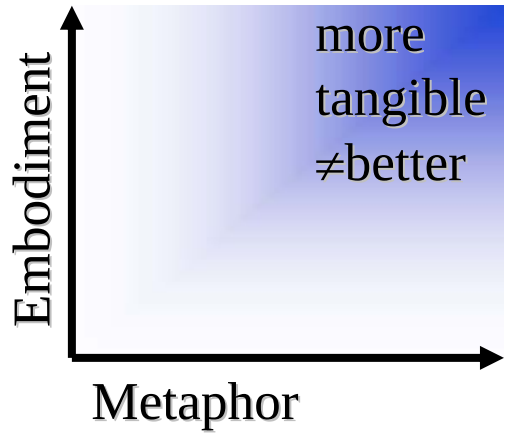
# Three Examples of TUIs - No3

- “ToonTown” - Singer et al. (1999)
  - Toon figures representing users of an audio chat system.
  - While moving the figures the audio levels are adjusted.

# 2-D Tangibility Space

- The examples show how different tangible interfaces can be.
- Fishkin found no useful binary characteristic function. Instead he sees “tangibility” as a multi-valued attribute.

- 2 Dimensions



# First Axis: Embodiment


Extend the user thinks the states of the system being “inside” the object they are manipulating.

- Full
  - Most common type in the physical world.
  - E.g. shaking, tilting, bending a PDA.

  ➔The output is in the input device.
- Nearby
  - E.g. light pen altering the display content.

  ➔Output is tightly coupled to the focus of input.

# Embodiment cont.

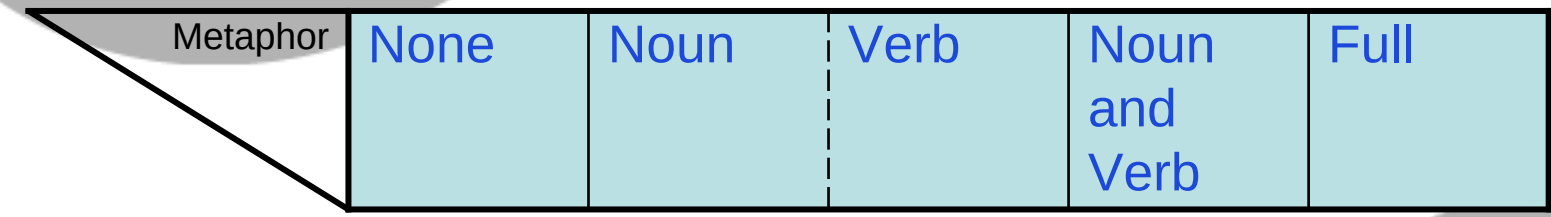
- Enivronmental
  - E.g. sound, ambient light or heat levels.

    ➔ Output is around the user.
- Distant
  - E.g. TV remote control.

    ➔ Output is “over there” on a display or
    even in another room.
  - Visual attention has to be switched.

# Second Axis: Metaphor

Extend the user experiences the system effect of his action being analogous to the real-world effect of similar actions.




## 1. None

- E.g. command line interface or keyboard.

# Metaphor cont.

## 2A. Noun

- Shape, look, sound, feel analogy. But analogy ends with the appearance. (Interaction differs)

➔"An <X> in our system is like an <X> in the real world."

- E.g. "windows/desktop" systems or invoking actions by bringing objects close to the computer.

## 2B. Verb

- Analogy of the act being performed. But shapes of the object are largely irrelevant.
- "<X>-ing in our system is like <X>-ing in the real world."
- E.g. embodied user interfaces (next week)

# Metaphor cont.

3. Noun and verb
   - “<X>-ing an <A> in our system is like <X>-ing something <A>-ish in the real world.”
   - E.g. drag-and-drop into the wastebasket (Debate on Apple’s floppy disk eject)
4. Full
   - No need for analogy because in the users mind the virtual system is the physical system.
   - E.g. pen computers (stylus is altering doc)

# Taxonomy by Fishkin

| Metaphor / Embodiment | None | Noun | Verb | Noun and Verb | Full |
|---|---|---|---|---|---|
| Full | | | | | |
| Nearby | | | | | |
| Env. | | | | | |
| Distant | | | | | |

# Analyzing the Examples

| Metaphor / Embodiment | None | Noun | Verb | Noun and Verb | Full |
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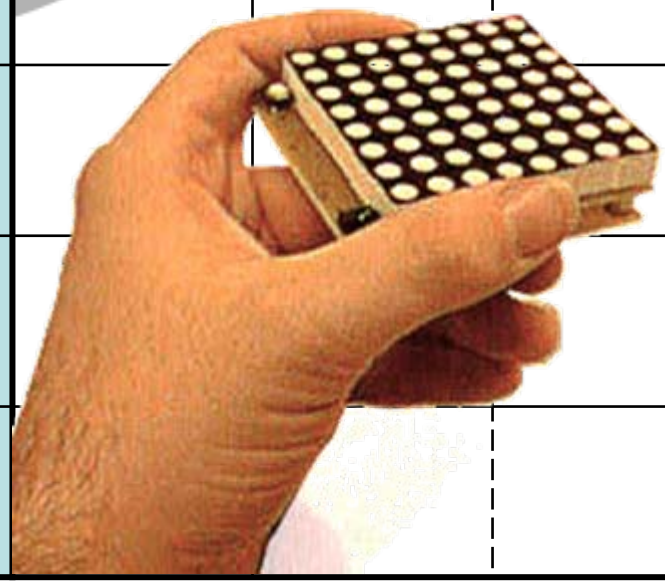

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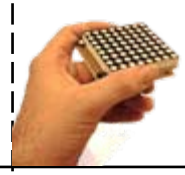
| Full | | |  | | |
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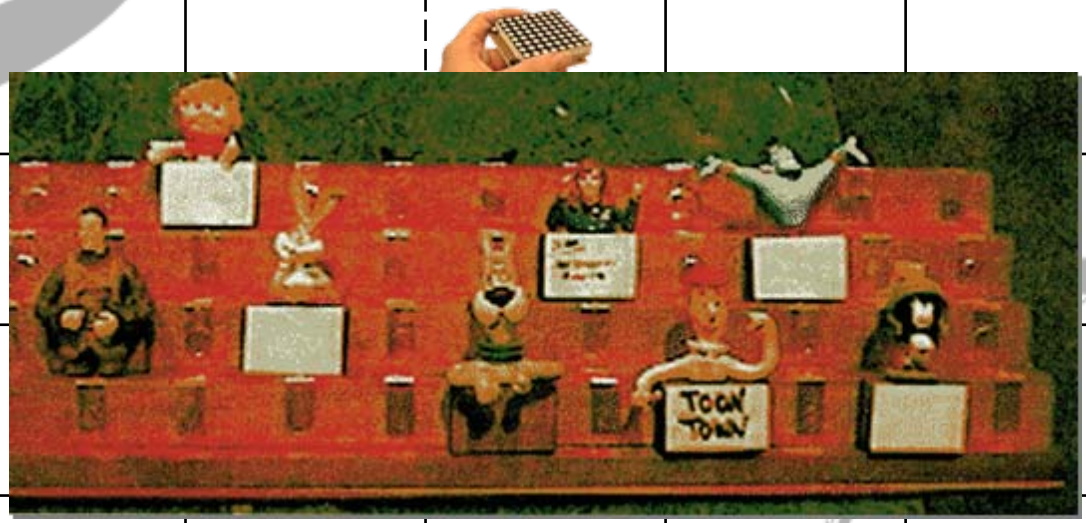

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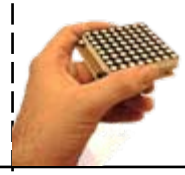
| Full | | |  | | |
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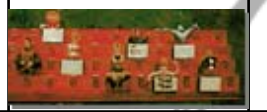
| Env. | | | |  | |
| Distant | | | | | |

# Even More Examples

| Metaphor / Embodiment | None | Noun | Verb | Noun and Verb | Full |
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| Full | | | | | |
| Nearby | | | | | |
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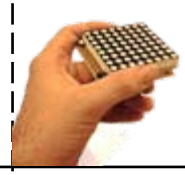
| Full | | |  | | |
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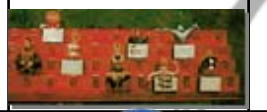
| Env. | | | |  | |
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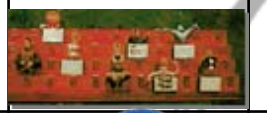
| Env. | | | |  | |
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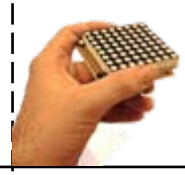
| Full | | |  | | |
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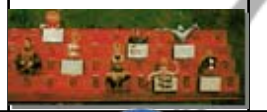
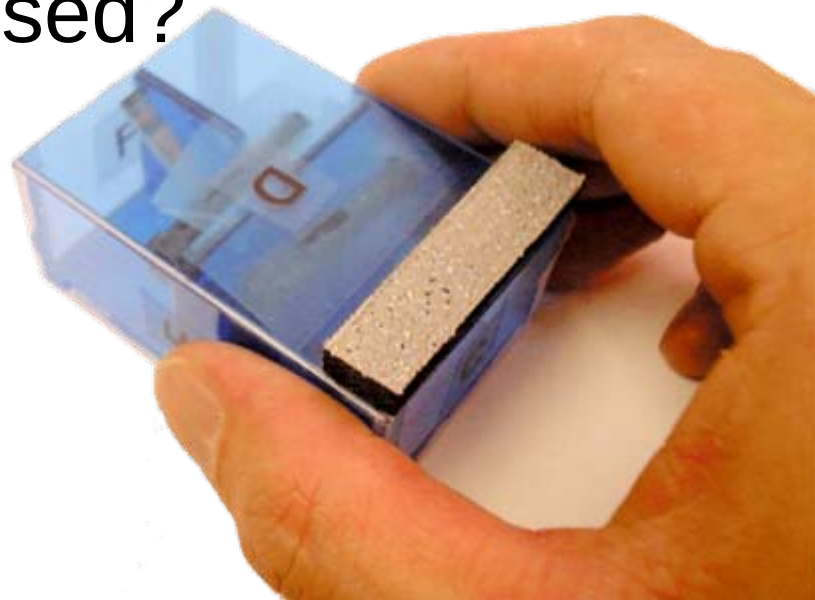
| Env. | | | |  | |
| Distant |  | | |  | |

# Back to the ToolStone

- To which categories does the ToolStone belong to?

- What is the level of embodiment?
- Which metaphors are used?



# Analyzing the ToolStone

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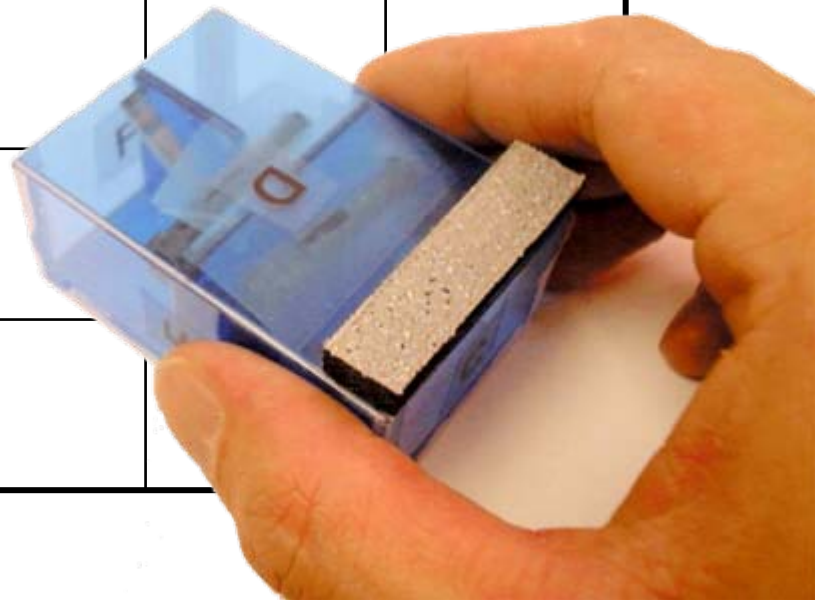

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# Analyzing the ToolStone

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| Full | | | | | |
| Nearby | | | | | |
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| Distant | | | | | |

- Nearby
  - Tool palette is visible on the screen.
  - No serious visual distraction.
- Verb
  - E.g. “Moving the stone is like moving the camera.”
  - But shapes are not (yet) analogized to any real-world physical object.

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- ToolStone as a powerful extension for the non-dominant hand.
- Simultaneously feedback important.

- Taxonomy may not drawn sharp enough.
- One need deep knowledge in the theory and in the project.
- Single project get different values for its different functions.

# Conclusions

- Leaving the conceptional computer virtual world, taking steps into the physical world.

- Away from computer-human interfaces into the realm of human interfaces in general.
- Greater design space. Lower barrier for non-professionals.

- ‘Tangible user interface’ might someday sound like ‘horseless carriage’. (D. Bishop)

# Thank you for your attention!

Questions & Discussion

# The Marble Answering Machine

| Metaphor / Embodiment | None | Noun | Verb | Noun and Verb | Full |
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| Full | | | | | |
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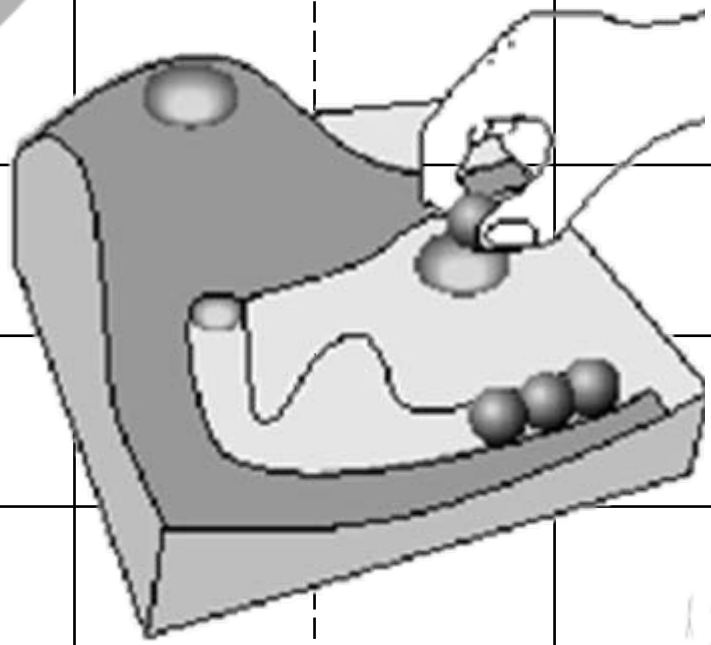

# The Marble Answering Machine

| Embodiment \ Metaphor | None | Noun | Verb | Noun and Verb | Full |
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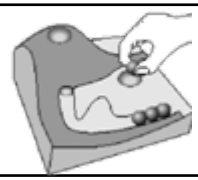
| Env. | | |  | ? ? | |
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