

Tangible User Interfaces

Research investigation and exploration

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"We live in a complex world, filled with myriad objects, tools, toys, and people. Our lives are spent in diverse interaction with this environment. Yet, for the most part, our computing takes place sitting in front of, and staring at, a single glowing screen attached to an array of buttons and a mouse."

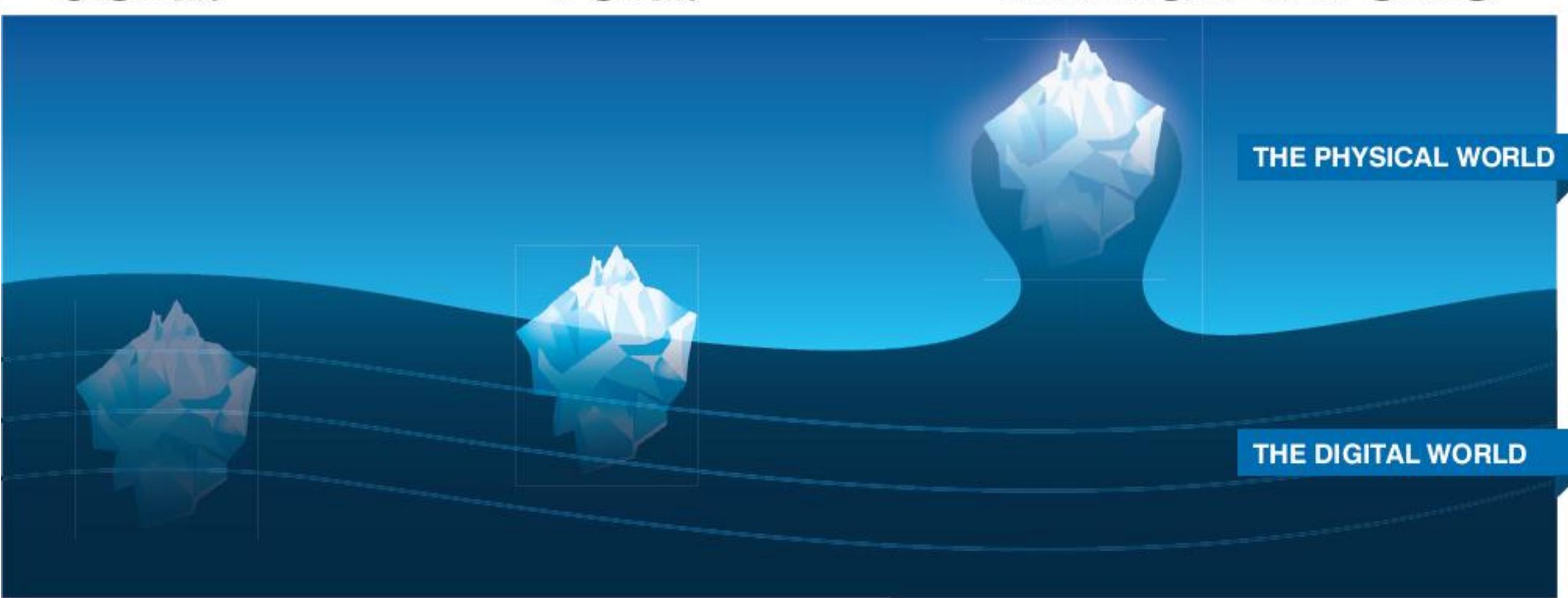
-by Mark Weiser

Tangible: Anything and everything which we can touch and feel









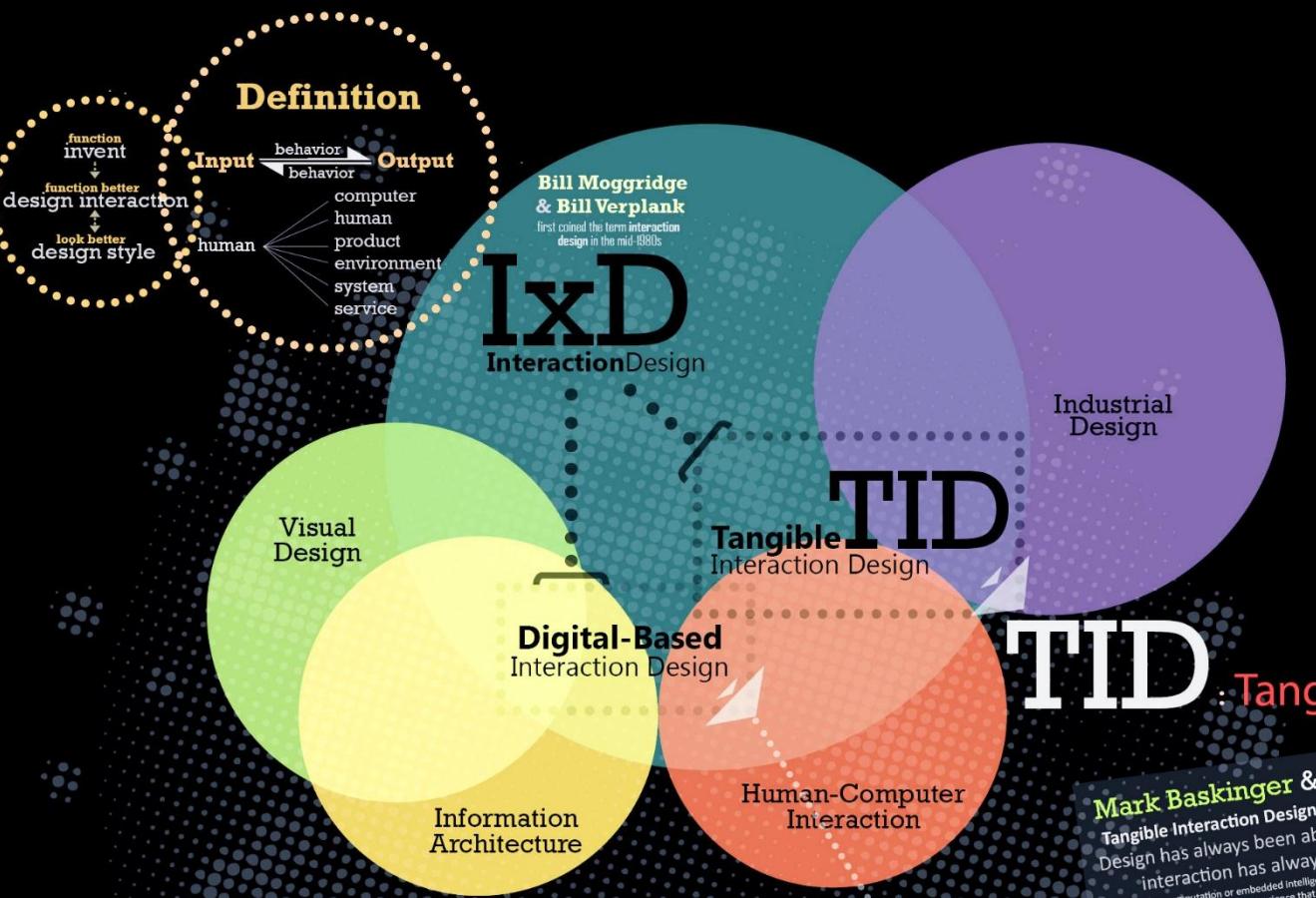
- a) A graphical user interface only lets users see digital information through a screen, as if looking through the surface of the water. We interact with the forms below through remote controls such as a mouse, a keyboard, or a touchscreen.
- b) A tangible user interface is like an iceberg: There is a portion of the digital that emerges beyond the surface of the water – into the physical realm – that acts as physical manifestations of computation, allowing us to directly interact with the "tip of the iceberg."
- c) Radical Atoms is our vision for the future of interaction with hypothetical dynamic materials, in which all digital information has physical manifestation so that we can interact directly with it – as if the iceberg had risen from the depths to reveal its sunken mass.

"Grasp and Manipulate" Bits

*"A **Tangible User Interface** gives physical form to digital information and computation, salvaging the bits from the bottom of the water, setting them afloat, and making them directly manipulatable with human hands."*

-by Hiroshi Ishii





Designing TID

Tangible Interaction
A new discipline which has a long history.

theories

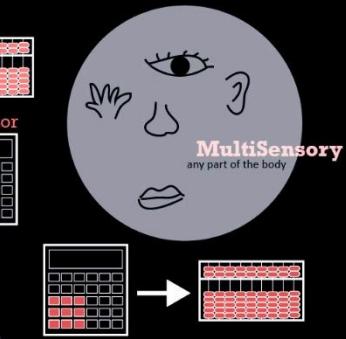
Patty's interpretation

Past TID **Input** → **Output**
 Physical Physical

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graph LR
    A[Present TID] --> B[Input]
    B --> C[Computing]
    C --> D[Output]
    
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The diagram illustrates the process flow. It starts with 'Present TID' at the top left, followed by an arrow pointing right to 'Input'. Another arrow points right from 'Input' to '(Computing)'. A final arrow points right from '(Computing)' to 'Output'. Below each main term are two smaller terms: 'Physical/Digital' under 'Present TID', 'Digital' under 'Input', and 'Physical' under 'Output'. Below '(Computing)' are the words 'new elements' and 'not limited'.

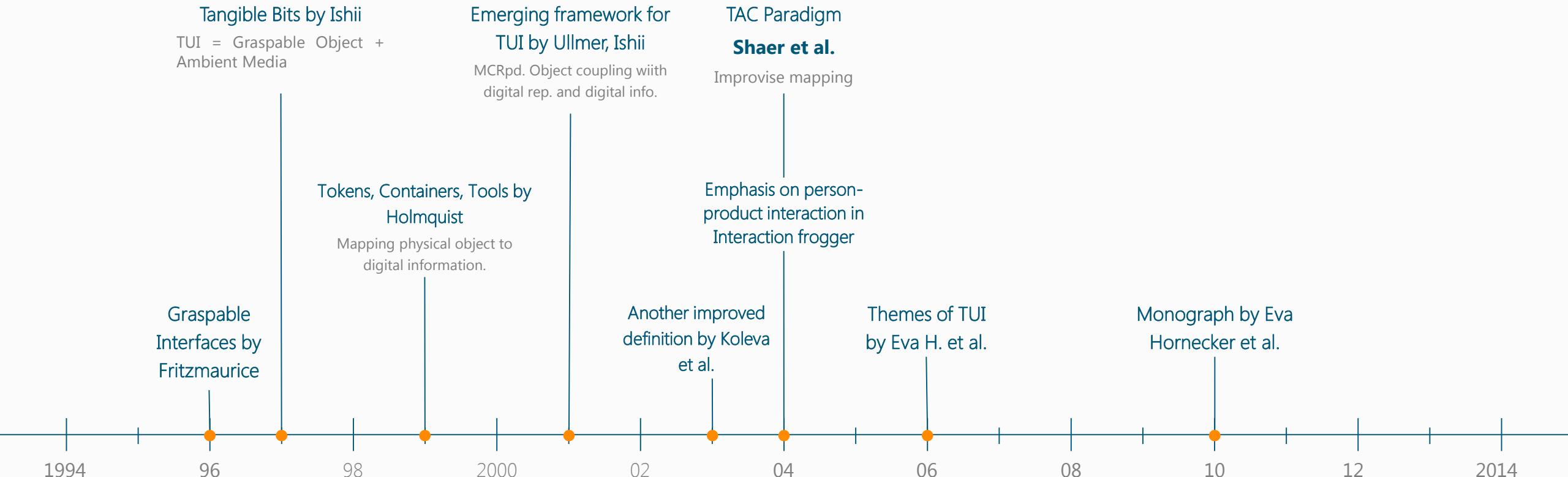


Tangible Timeline

Timeline of different Classification and frameworks (theoretical papers)

The TUI timeline

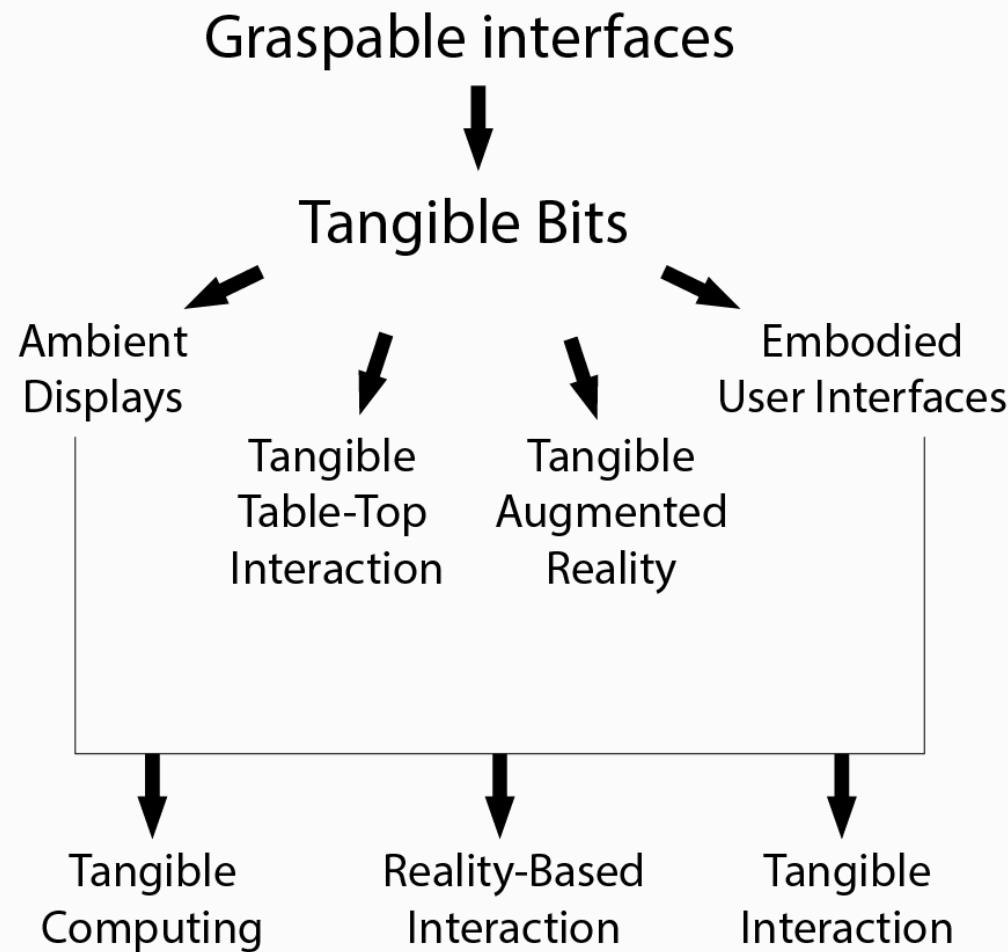
past works in tui



Unifying Perspective

Research investigation and exploration of Tangible User Interfaces

Evolution of TUI



Tangible Computing

Integrating computations in everyday life using concepts of
TUIs, Ubiquitous Computing, Augmented Reality, Reactive Rooms, and
Context-Aware Devices

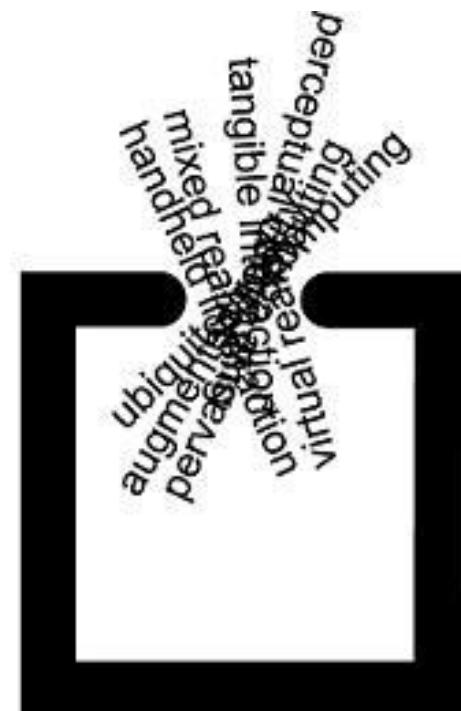
Tangible Interaction

Focuses on the user experience and interaction with a system

Reality-Based Interaction

Consolidates broad range of interaction styles including virtual reality, augmented reality, ubiquitous and pervasive computing, handheld interaction, and tangible interaction

Reality-Based Interaction





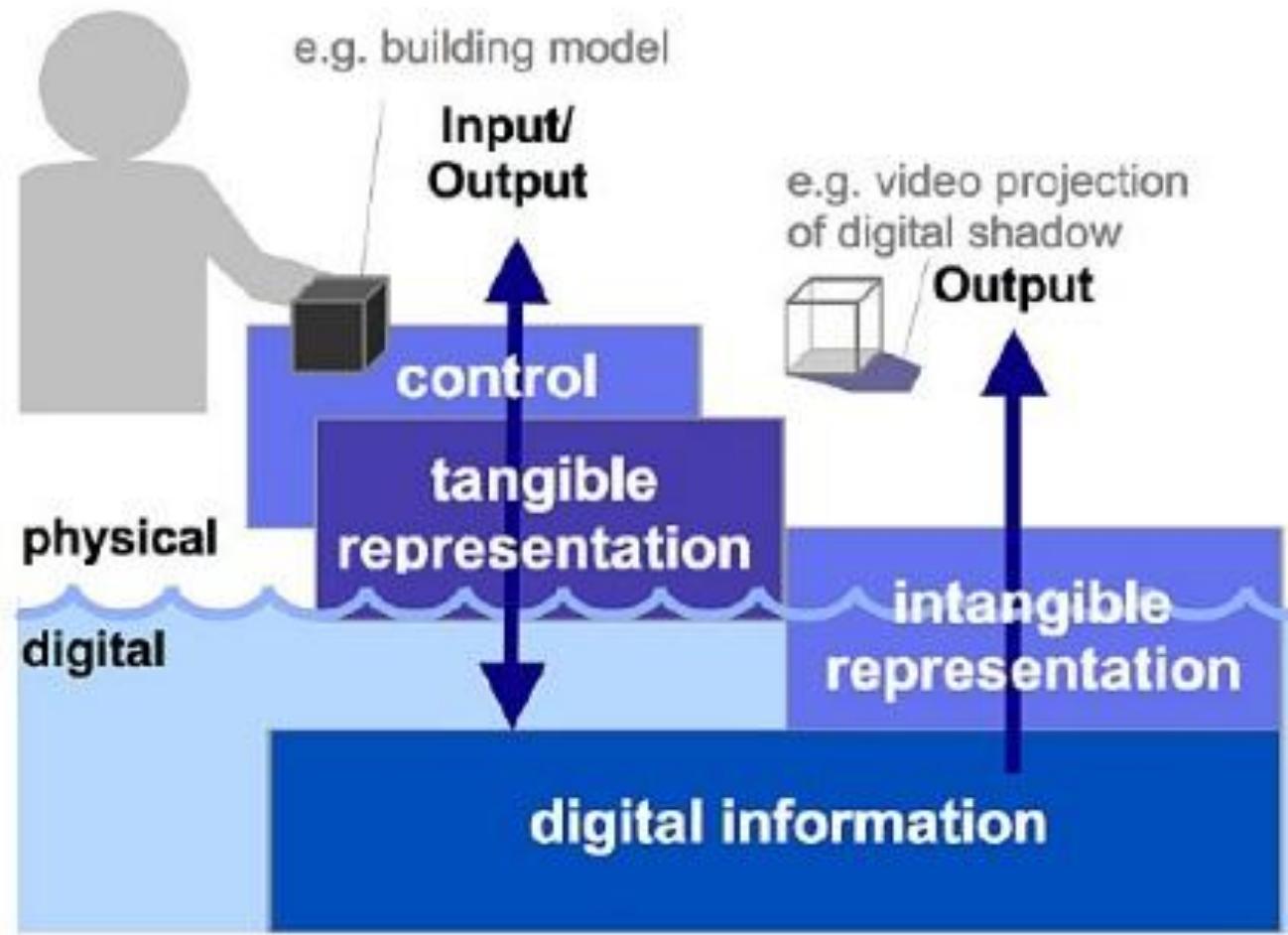
What are we doing??

I'm confused,
oh wait,
maybe I'm not

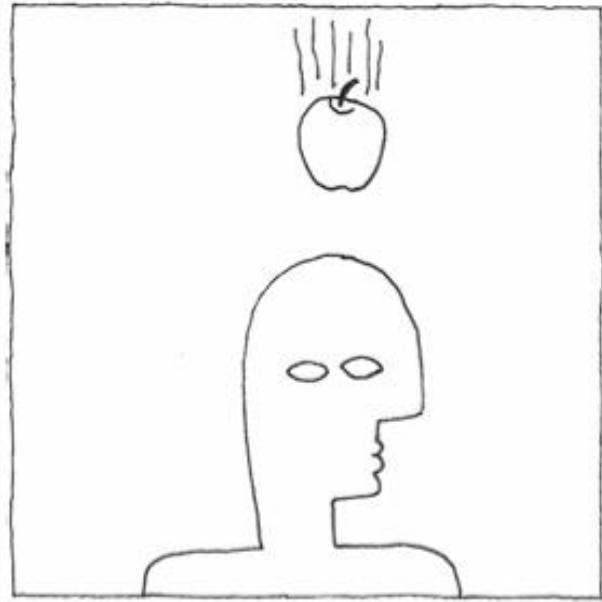
Trying to ANALYSE this domain, SEARCH for trends
and UNDERSTAND TUI from OUR PERSPECTIVE!!

MCRpd

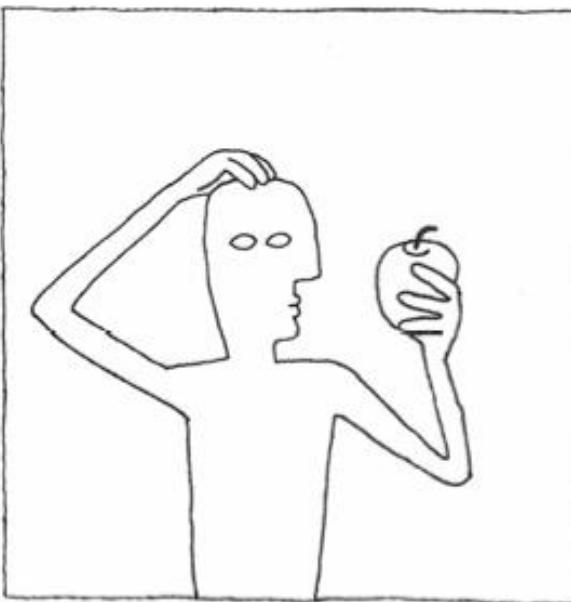
Model Control and Representation



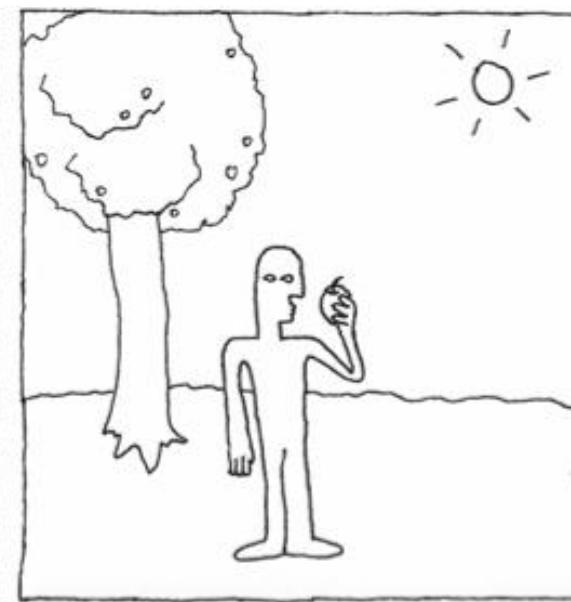
- tangible objects are coupled via computerized functionality with digital data (computational coupling);
- the tangible objects represent the means of interactive control. Moving and manipulating objects is the dominant form of control;
- the tangible objects are perceptually coupled with digitally produced representations (e.g., audio and visuals);
- the state of the tangible objects embodies core aspects of the entire system's state (representational significance). (the system is thus at least partially legible if power is cut);



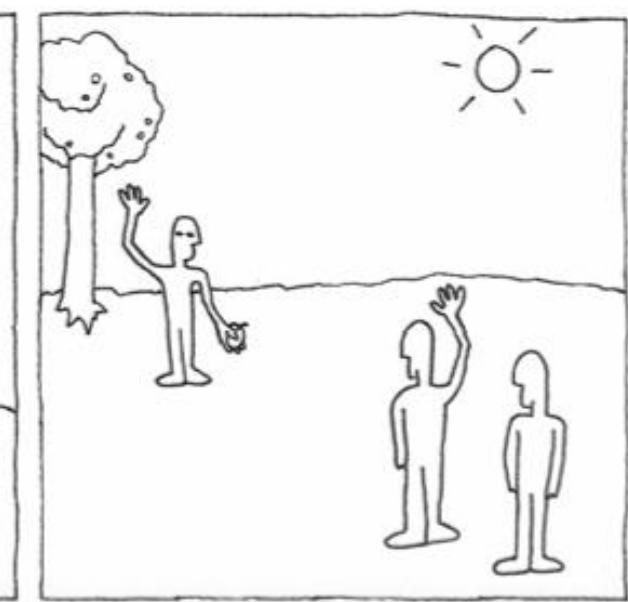
Naïve Physics



Body Awareness & Skills



Environment Awareness & Skills



Social Awareness & Skills

Reality-Based Interaction

Naive Physics: the common sense knowledge people have about the physical world.

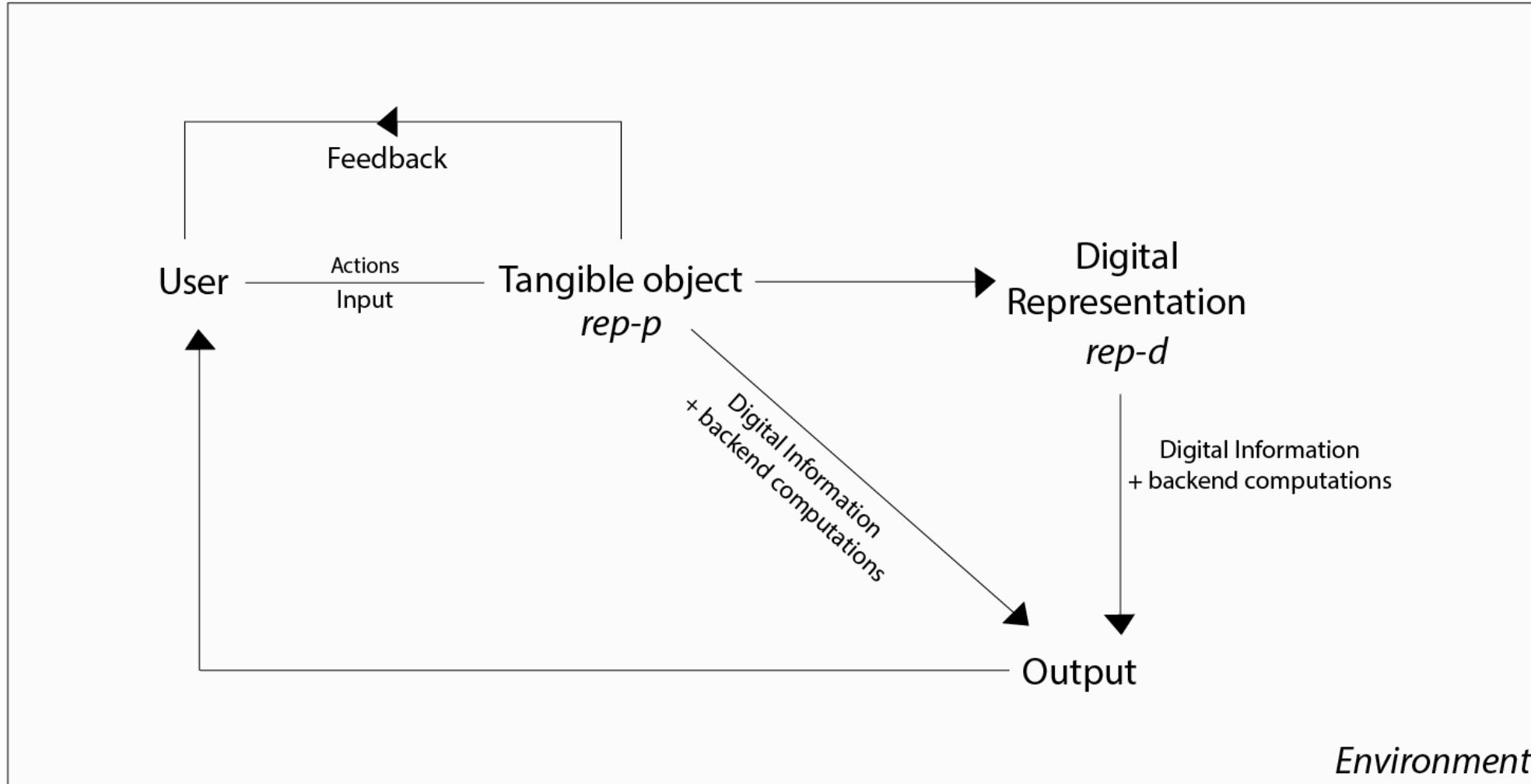
Body Awareness and Skills: the awareness people have of their own physical bodies and their skills of controlling and coordinating their bodies.

Environment Awareness and Skills: the sense of surroundings people have for their environment and their skills of manipulating and navigating their environment

Social Awareness and Skills: the awareness people have that other people share their environment, their skills of interacting with each other verbally or non-verbally, and their ability to work together to accomplish a common goal.

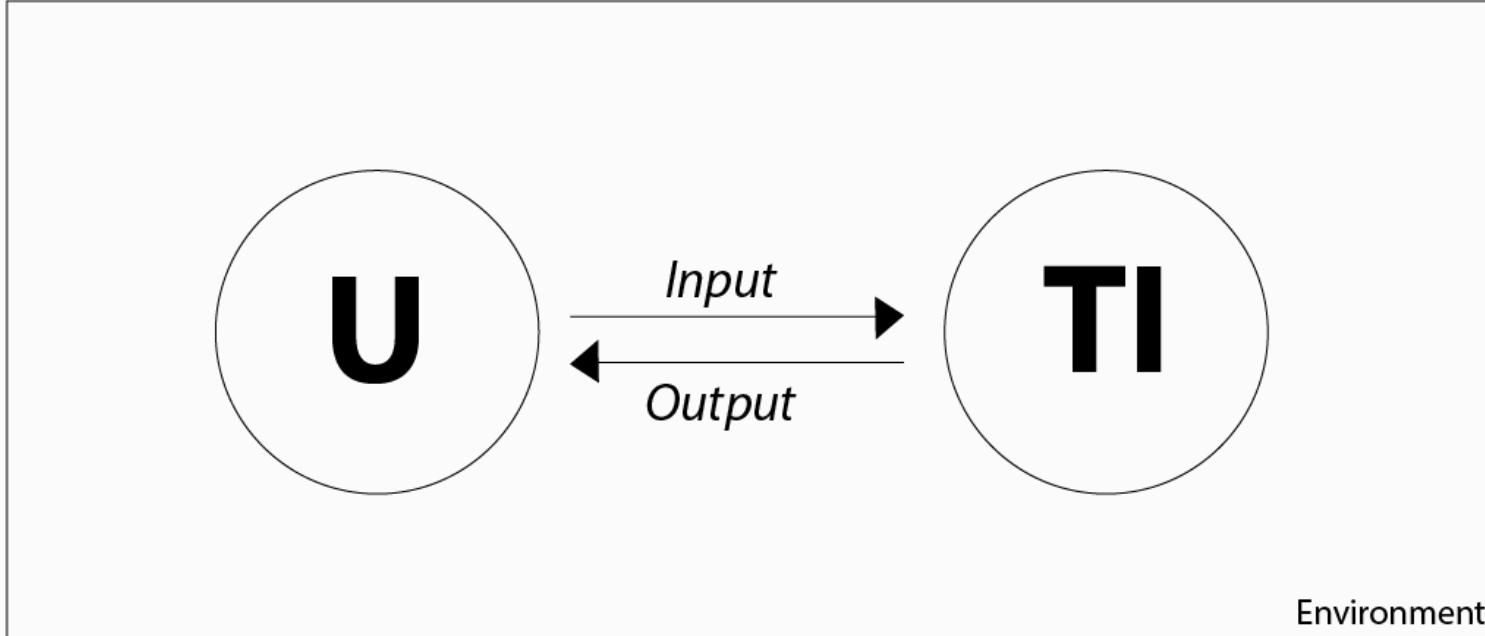
Extending MCRpd

Studying interaction between most common elements of TUI



Unifying Perspective

Studying interaction between TUI system and



U = Naive Physics

U + U = Social Awareness

U + E = Environment Awaitness

U + Input/Actions = Body Awareness

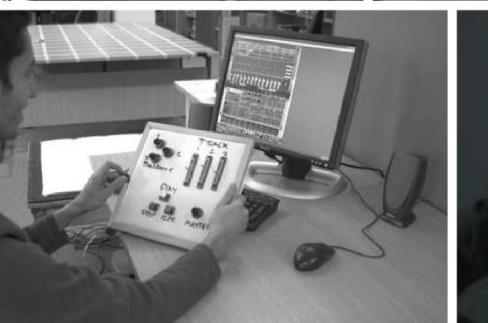
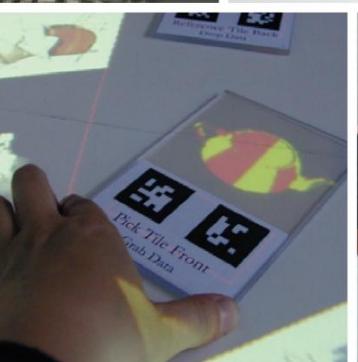
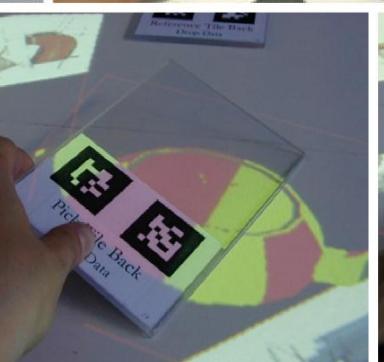
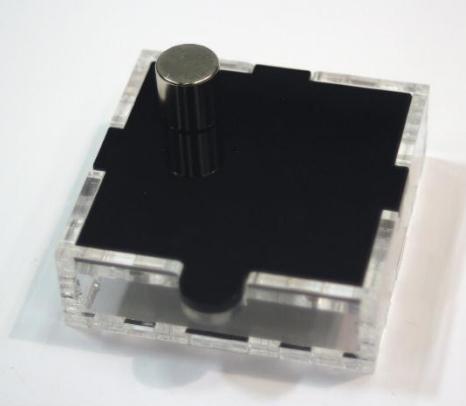
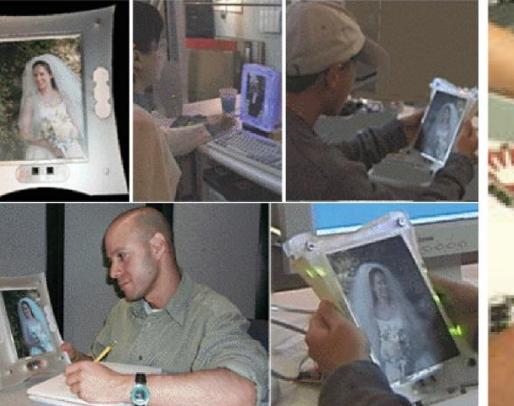
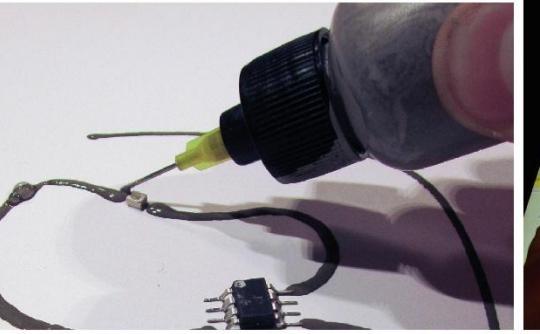
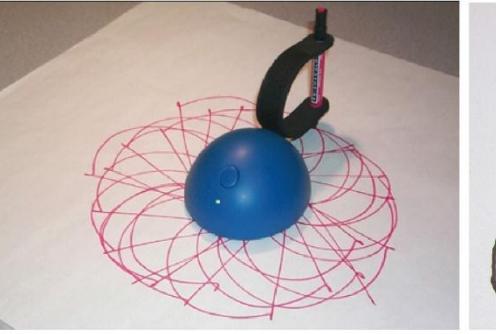
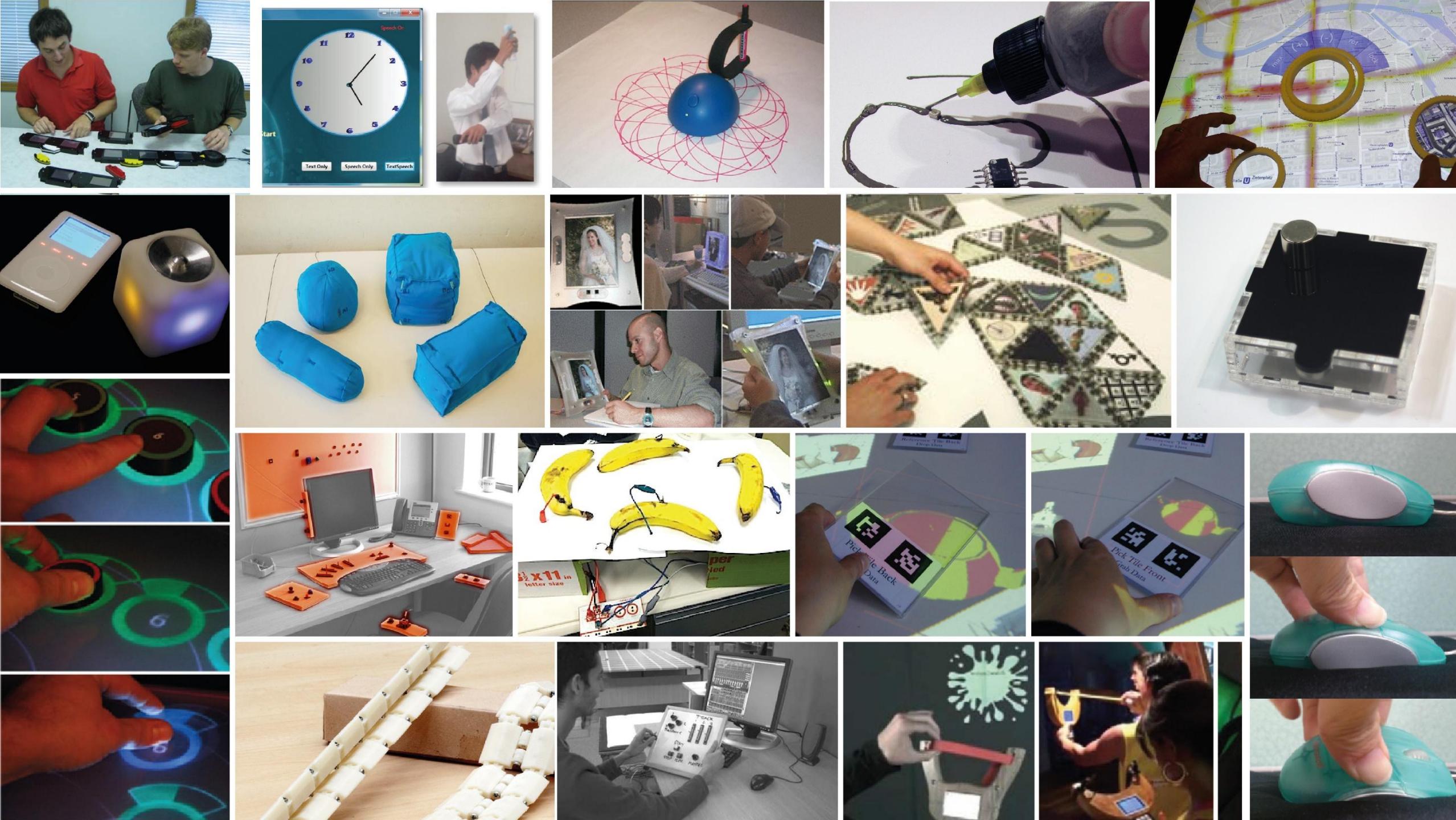
Classification

We tried to figure out focus areas of TUI frameworks (based on MCRpd model and reality based interfaces)



READ!!
READ!!
READ!!

CLASSIFIED!!



for whole system

Application Domain

TUIs for Learning

Problem Solving and Planning

Information Visualization

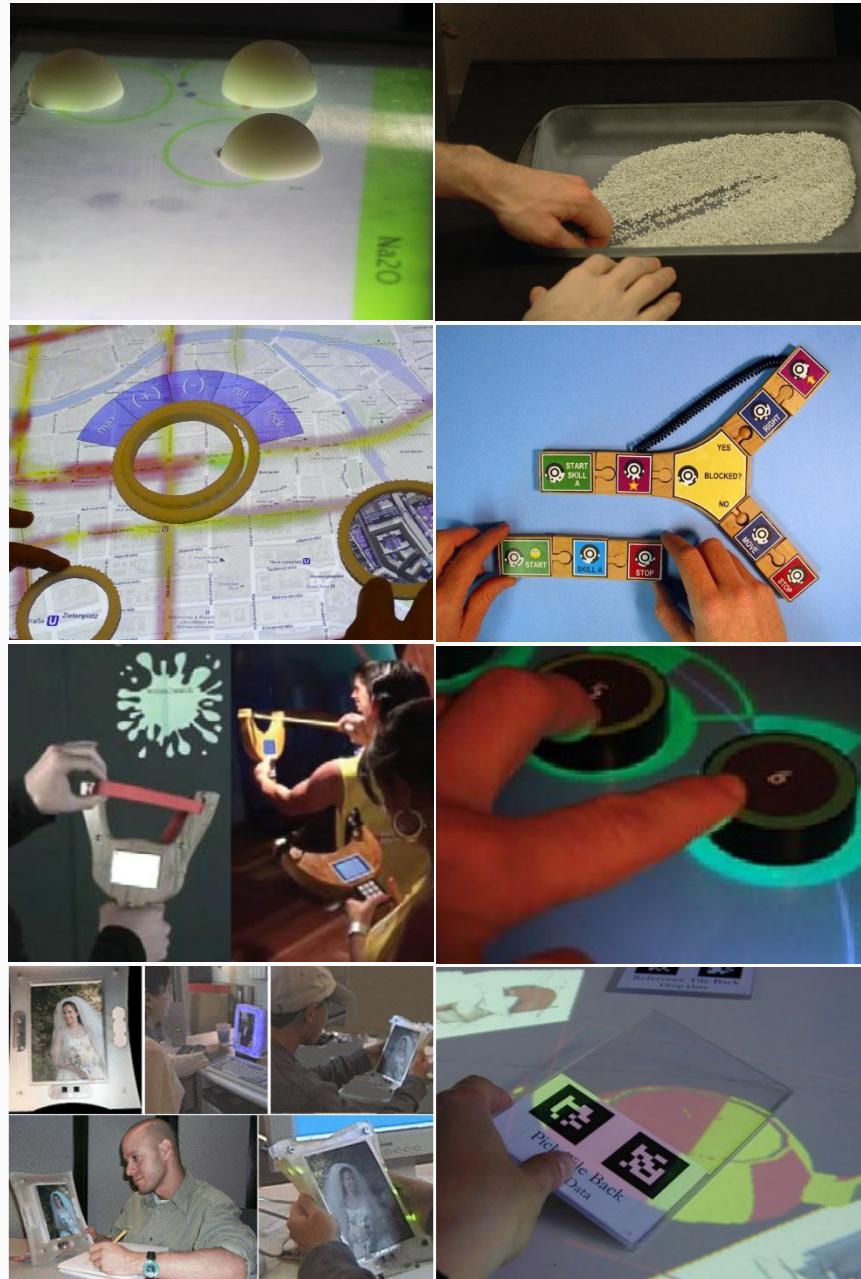
Tangible Programming

Entertainment, Play, and Edutainment

Music and Performance

Social Communication

Tangible Reminders and Tags



Analogy b/w the interface and action

Metaphor of noun

objects look like a real thing or object used in everyday life. Though the actions are mostly weakly related to the real world actions.

Metaphor of verb

objects are not likely to look like real thing or objects used in everyday life. But the action of objects is like a real thing.



Human-tangible object coupling

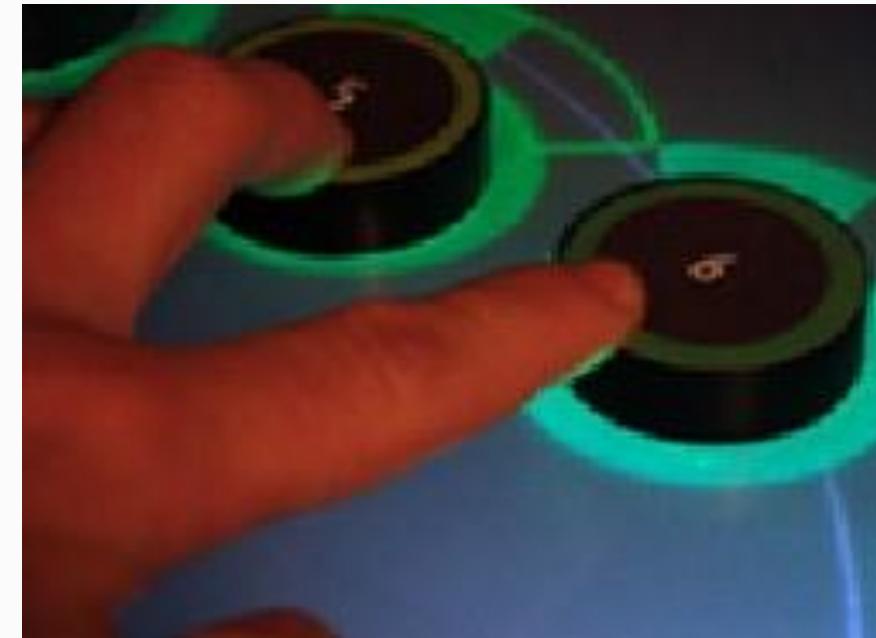
Affordances



Perceptual Coupling

Coupling between tangible object and its digital representation.

How good is this coupling?



Spatial, relational and constructive

Spatial

the spatial configurations of physical objects are directly interpreted and augmented by the underlying system.



Relational

the sequence, adjacencies, or other logical relationships between systems of physical objects are mapped to computational interpretations.



Constructive

the relationship between physical objects when mechanically linked together forming constructive assembly

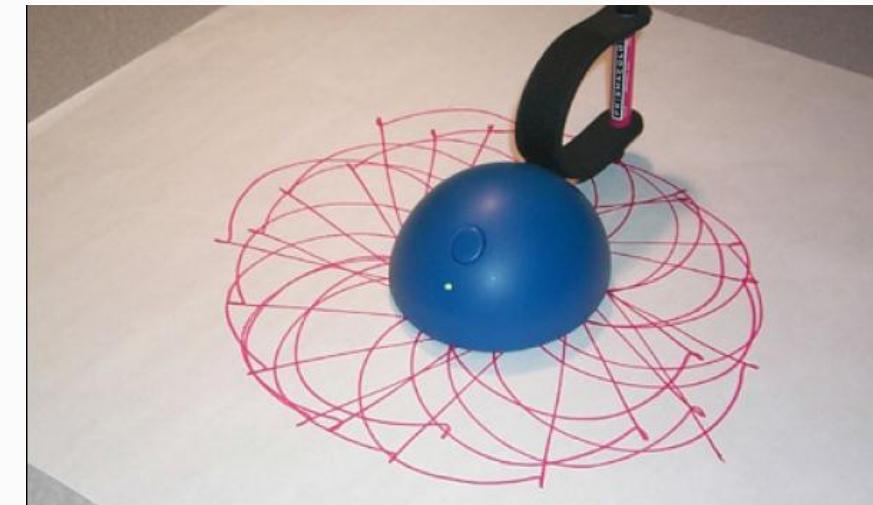


Mapping of digital info to tangible object

Tokens

Containers

Tools



Coupling b/w product action and its function

Time (immediate feedback)

Location (co-located input and output)

Direction (similar direction of the user's movement and that of the product's reaction)

Dynamics (whether the dynamics (position, speed, acceleration, force) of the user's action is coupled to the dynamics of the product's response)

Modality (sensory modalities of action and product reaction are similar)

Expression (product's reactions reflects the emotional expression of the input action)



Embodiment axis

Full (output device is the input device)

Nearby (output takes place near the input object)

Environment (output is around the user)

Distant (output is on another screen or even in another room)



Output Coupling

Action performed and its perceived output v/s actual output.



Information in interaction with the product

Functional Info (direct result of the product's function)

Augmented Info (informs the user about the internal state of the product)

Coherent Info (results directly from the user's action)

TUI System

Direct Manipulation (time)

Behavioral Specification (activation)

Communication Channels (different time and space)

Method of Coupling

Static Binding

binding that is specified by the system's designer and cannot be changed within the tangible interface itself

Dynamic Binding

binding that is specified within the tangible user interface, typically by the user of the system



for whole system

Prototype and Evaluation

Was prototype made?

Was evaluation done?

What kind of study was conducted?

Iconic or Symbolic

Iconic

digital information is reflected in the tangible object

Symbolic

digital information is not reflected in the tangible object



Research Areas

Research investigation and exploration of Tangible User Interfaces

Combining theories of gestural interfaces and tangible interfaces and studying the impact and extent of gestures in tangible interfaces.

TUI vs. GUI in terms of computational functionalities.

Which system is better and preferable in different contexts based on computational workload, amount of data to be handled, etc.?

Effectiveness of different interaction modalities in different contexts. What is the extent of penetration of multimodal interactions in tangible interactions?

Interplay of different interaction modalities for efficient feedback and input/output coupling and comparing it with traditional visual desktop metaphor.

Reality Based Interaction

Where does TUI lie in the whole paradigm of reality-based interactions?

How does the model affect the vision of TUI?

Future Work

1. Read and consolidate our observations
2. Finalize on one of the areas of work
3. Re-search again!!
4. Propose an Hypothesis
5. Prove/Disprove it through experimentation!!

Deliverable

A thoroughly validated STATEMENT which contributes to the ongoing research in TUI

Blogging!!

<https://medium.com/interaction-modalities/>

References

- Ishii, Hiroshi, and Ullmer, Brygg. "Tangible bits: towards seamless interfaces between people, bits and atoms." *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems*. ACM, 1997.
- Ullmer, Brygg, and Ishii, Hiroshi. "Emerging frameworks for tangible user interfaces." *IBM systems journal* 39.3.4 (2000): 915-931.
- Ishii, Hiroshi. "The tangible user interface and its evolution." *Communications of the ACM* 51.6 (2008): 32-36.
- Edge, Darren. "Tangible user interfaces for peripheral interaction." *University of Cambridge, Computer Laboratory, Technical Report UCAM-CL-TR-733* (2008).
- Mazalek, Ali, and Elise Van Den Hoven. "Framing tangible interaction frameworks." *AI EDAM (Artificial Intelligence for Engineering Design, Analysis and Manufacturing)* 23.3 (2009): 225.
- Shaer, Orit, and Eva Hornecker. "Tangible user interfaces: past, present, and future directions." *Foundations and Trends in Human-Computer Interaction* 3.1–2 (2010): 1-137.
- Hornecker, Eva. "Beyond affordance: tangibles' hybrid nature." *Proceedings of the Sixth International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 2012.

THE WOODS ARE LOVELY DARK&DEEP
BUT I HAVE PROMISES TO KEEP
AND MILES TO GO BEFORE I SLEEP
AND MILES TO GO BEFORE I SLEEP

(ROBERT FROST)