

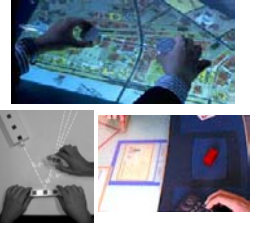
# A Framework for Tangible User Interfaces

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# Tangible User Interfaces

- Users interact directly with computational artefacts by manipulating everyday physical objects
- metaDesk (Ullmer & Ishii, 1997)
- Illuminating Light (Underkoffler & Ishii, 1998)
- Passage (Konomi, 1999)



# TUI Frameworks

- Model-Control-Representation physical and digital (MCRpd) (Ullmer & Ishii, 2001)
  - Foundation for identifying key characteristics of TUIs
  - Highlights integration of representation and control
- Holmquist's taxonomy (1999)
  - Functional roles server by TUI tangibles
    - Containers
    - Tokens
    - Tools



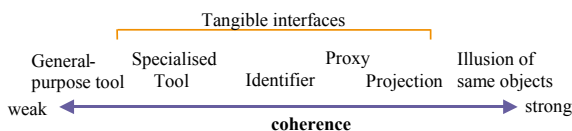
# Proposed Framework

- Aims:
  - Enrich our understanding of the different ways in which physical and digital objects can be computationally coupled
  - Systematic view of TUIs
- Core concepts:
  - Degree of coherence
  - Links between physical and digital objects
  - Underlying link properties



# Degree of Coherence

- The extent to which linked physical and digital objects might be perceived as being the same thing



# Link Properties (1)

- **Transformation** – whether the effect mediated between linked objects is literal or transformed
- **Sensing of Interaction** – what interactions with the interface object and its surrounding environment are sensed and transmitted to the destination object
- **Configurability of Transformation** – whether the transformation mediated between two linked objects remains fixed for the lifetime of the link or is configurable over time



## Link Properties (2)

- **Lifetime of link** – how long a physical and a digital object remain linked
- **Autonomy** – to what extent the existence of the destination object is reliant upon the existence of the link and the source object
- **Cardinality of link** – whether an object is linked to one or more objects
- **Link Source** – whether the source of the effect is the physical or the digital object

## Implications for TUIs (1)

- **Tangibles that push back**
  - Asymmetry in links between the physical and digital
  - Challenge to develop tangibles that react to changes in the digital world
    - Maintaining synchronisation
    - Monitoring digital activity
- **Mobility and TUIs**
  - Moving the physical element of TUIs between contexts
  - Charting this design space through considering lifetime, autonomy and configurability of links

## Implications for TUIs (2)

- Understanding the effects of TUIs as we establish richer forms of links
  - How is the variability in links presented to **developers**?
    - Toolkits and our proposed framework
  - How is the variability in links presented to **users**?
    - What are appropriate representations of link properties?
    - What feedback is provided?

## Conclusions

- Framework for TUIs based on the idea of **degree of coherence** between physical and digital objects
- Further broken down into concept of **links** that are described in terms if a set of underlying **properties**
- Shift in focus from current perspectives
  - Richness of potential links
- Future research directions