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# Les Interfaces Utilisateur Tangibles (TUI)

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*ESTIA, LaBRI*

*Présentation au LUCID Group  
Université de Liège  
12 Février 2008*

# Plan

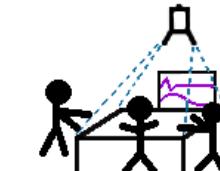
**Exemples de TUI**



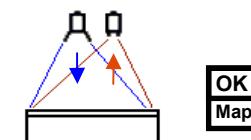
**Formalisation**



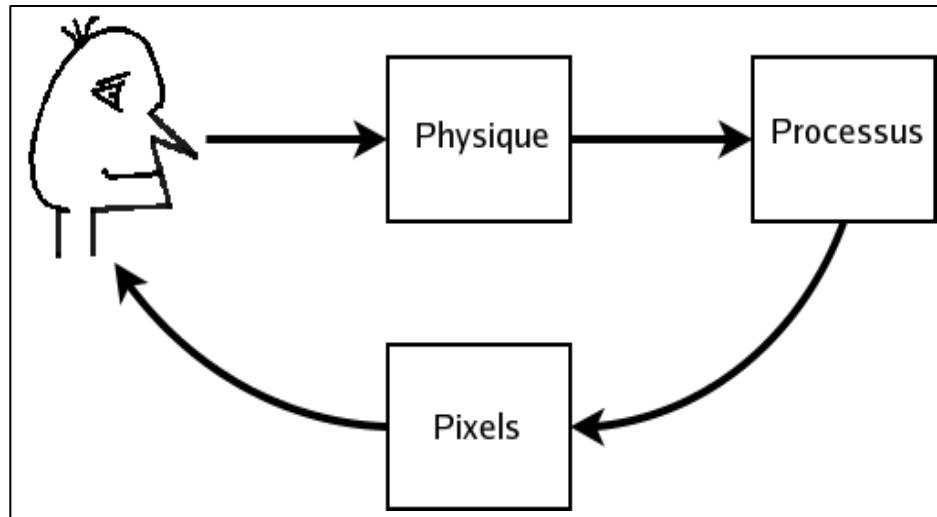
**TUI + Tabletop**



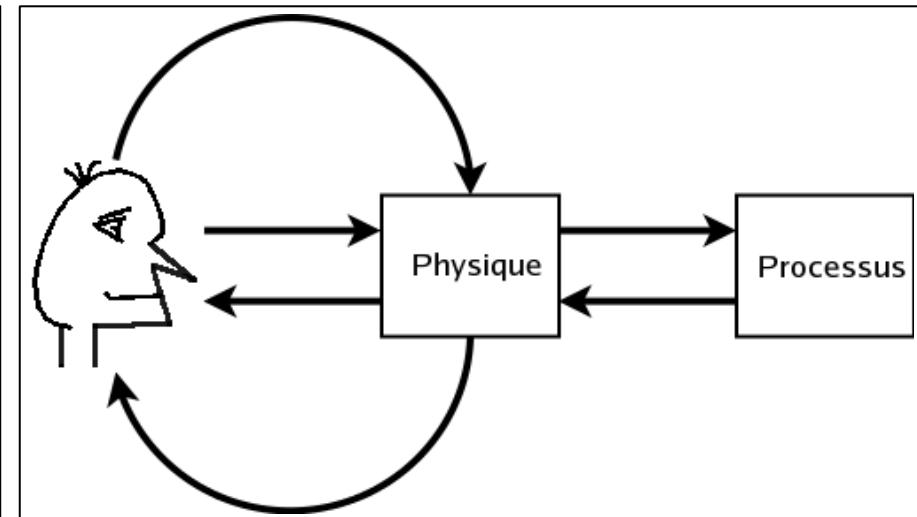
**Plateforme de GeoTUI**



# Boucle action/perception



*Interface Graphique  
(GUI)*



*Interface Tangible  
(TUI)*

# Exemples

- I/O Brush (*MIT, 2004*)



Ryokai, K., Marti, S. and Ishii, H., I/O Brush: Drawing with Everyday Objects as Ink, In *Proc. CHI 2004*, April 24-29, 2004, pp. 303-310.

# Exemples

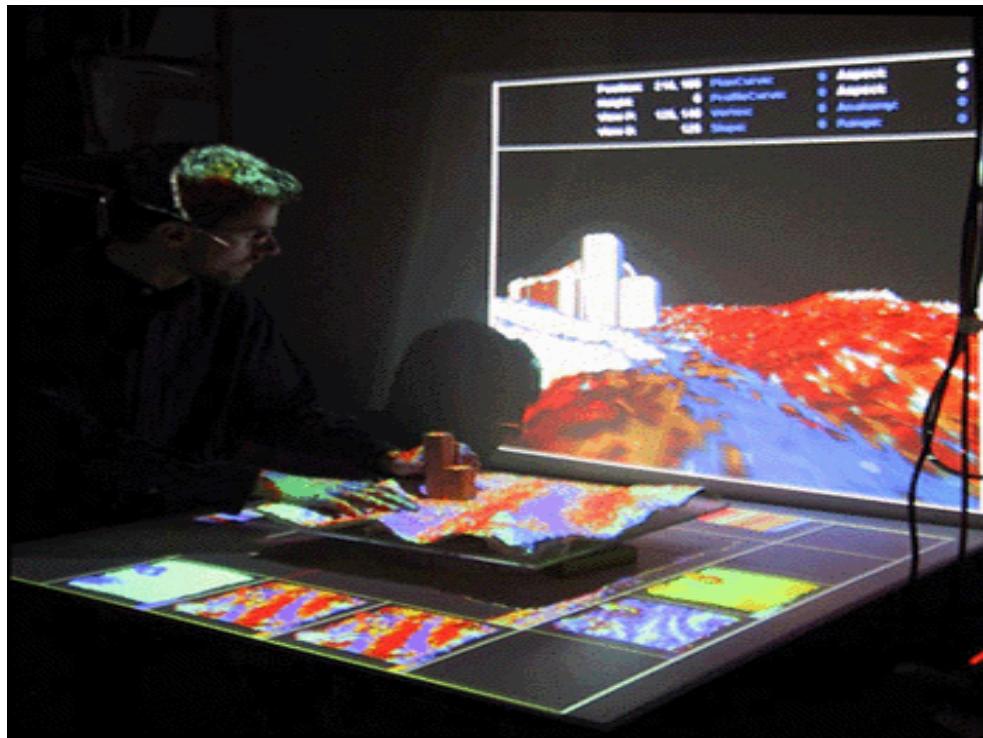
- **Active Cubes** (*Université d'Osaka, 2004*)



Watanabe, R., Itoh, Y., Asai, M., Kitamura, Y., Kishino, F. and Kikuchi, H., The Soul of ActiveCube - Implementing a Flexible, Multimodal, Three-Dimensional Spatial Tangible Interface. In *Proc. of International Conference on Advances in Computer Entertainment Technology*, ACE 2004, june 3-5, 2004, pp. 173-180.

# Exemples

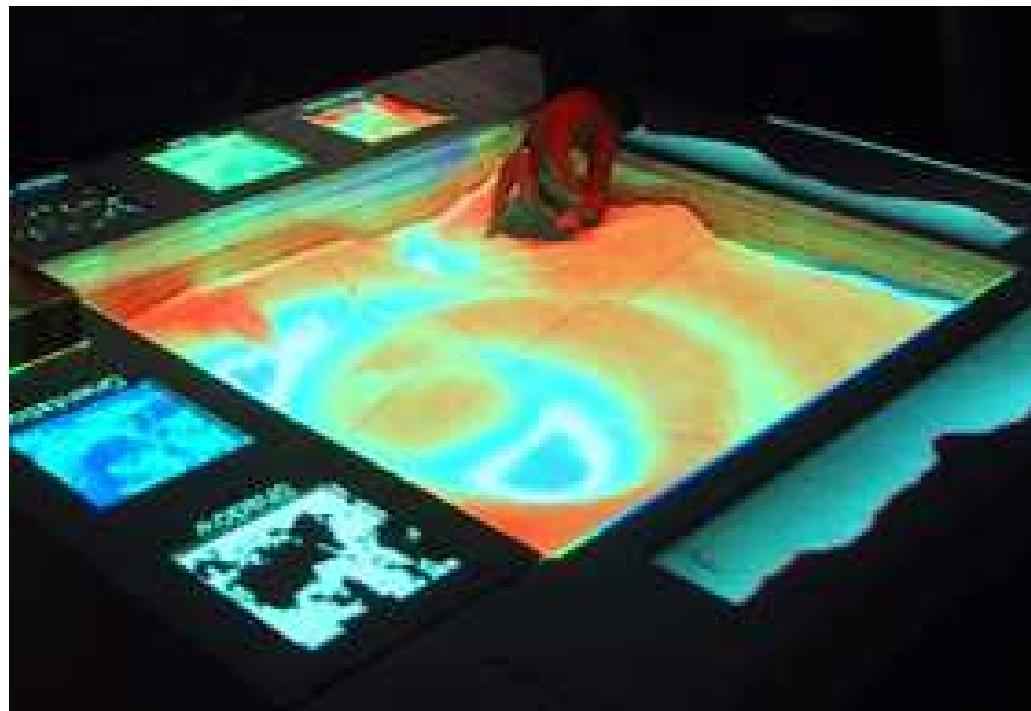
- Illuminating Clay (*MIT, 2002*)



Piper, B., Ratti, C. and Ishii, H.,  
Illuminating Clay : A 3-D Tangible Interface for Landscape Analysis.  
In Proc. CHI 2002, april 21-25, 2002, pp. 355-362.

# Exemples

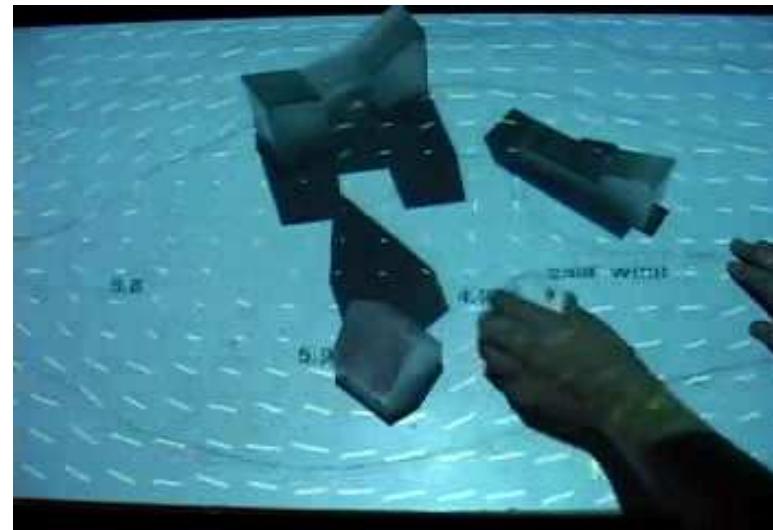
- **Sandscape (MIT, 2002)**



Hiroshi, I., 2002. [Sandscape an illuminated workbench for landscape design.](#) Ars Electronica.

# Exemples

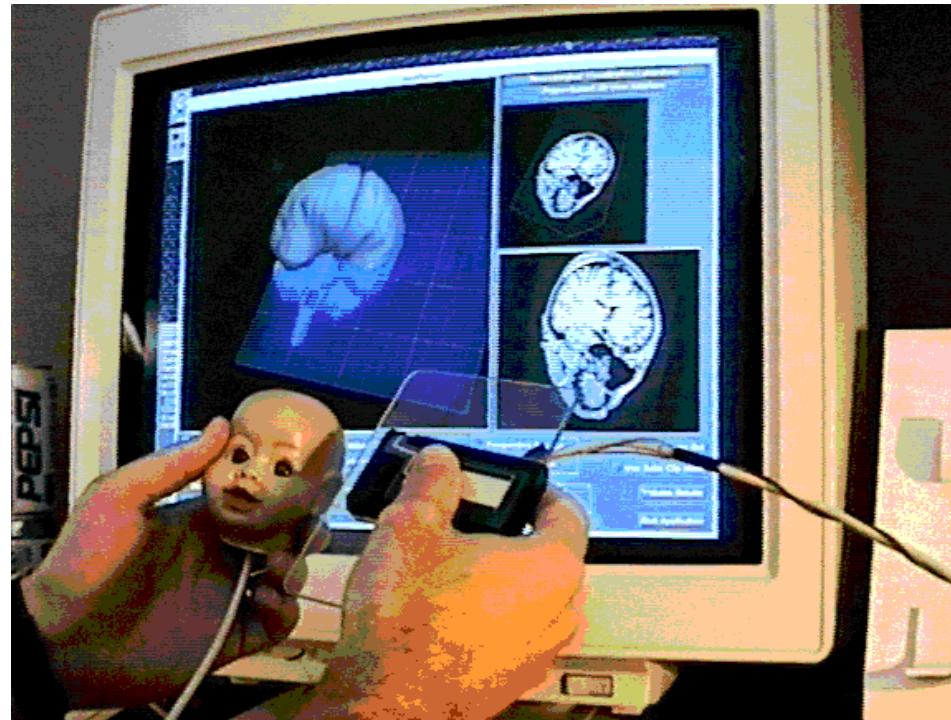
- **Urban Planning Workbench (MIT, 2002)**



Ishii, H., Underkoffler, J., Chak, D., Piper, B., Ben-Joseph, E., Yeung, L. and Kanji, Z., Augmented Urban Planning Workbench: Overlaying Drawings, Physical Models and Digital Simulation, *International Symposium on Mixed and Augmented Reality, ISMAR 2002*, Sept. 30 – Oct. 1, 2002, pp. 203- 211.

# Exemples

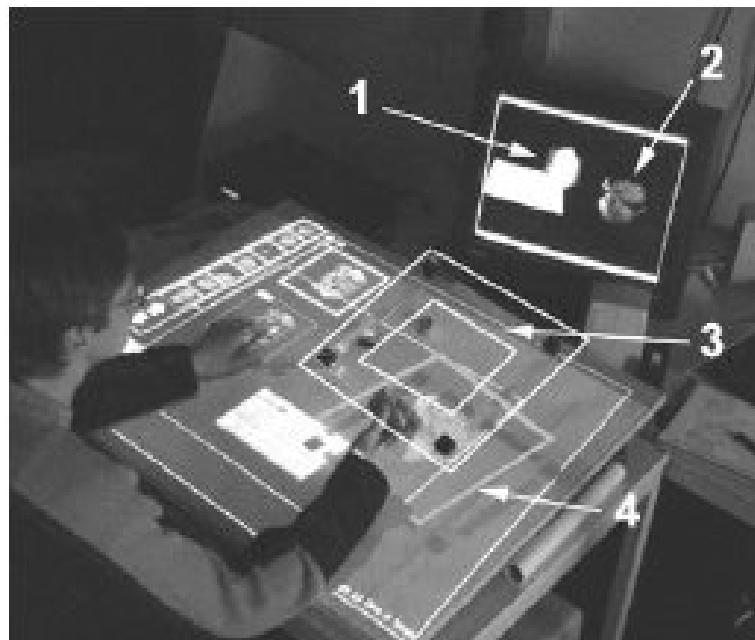
- Passive Props (1994)



Hinckley, K., Pausch, R., Goble, J.C. and Kassel, N.F. Passive Real-World Interface Props for Neurosurgical Visualization. In *proceedings of CHI '94*, ACM Press (1994), pp. 452-458.

# Exemples

- **Visual Interaction Platform (TUE, 2001)**



Aliakseyeu, D., Subramanian, S., Martens, J.B. and Rauterberg, M.,  
Interaction Techniques for Navigation through and Manipulation of  
2D and 3D Data. Proceedings of the Eighth Eurographics Workshop  
on Virtual Environments, EGVE'02, may 30-31, 2002, pp. 179-188.

# Exemples

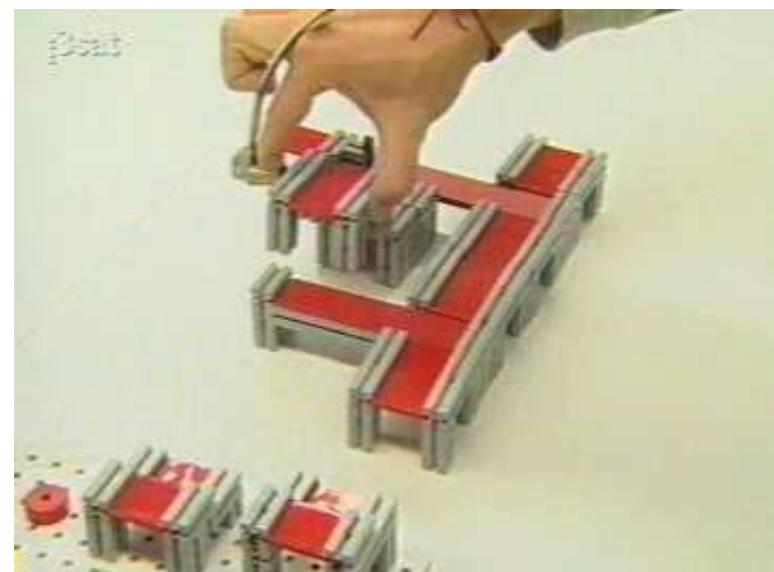
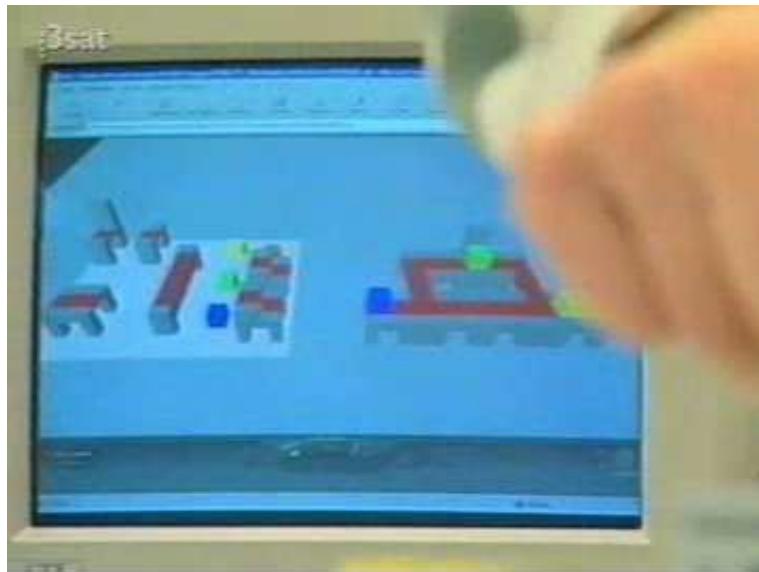
- **Phoxel Space (MIT, 2004)**



Ratti, C., Wang, Y., Piper, B., Ishii, H. and Biderman, A. PHOXEL-SPACE: an Interface for Exploring Volumetric Data with Physical Voxels. In *proceedings of DIS '04*, ACM Press (2004), pp. 289-296.

# Exemples

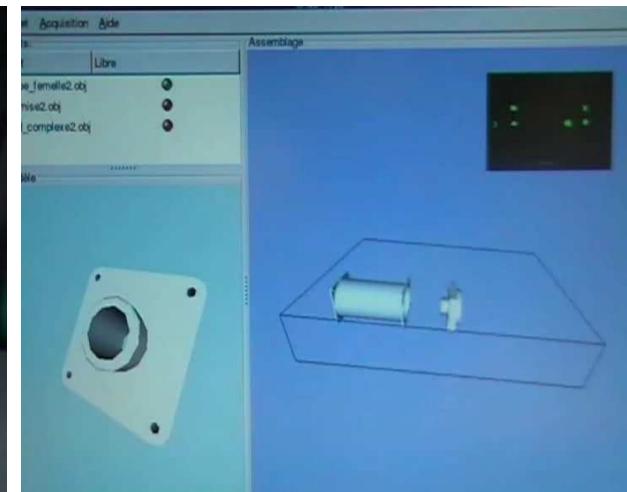
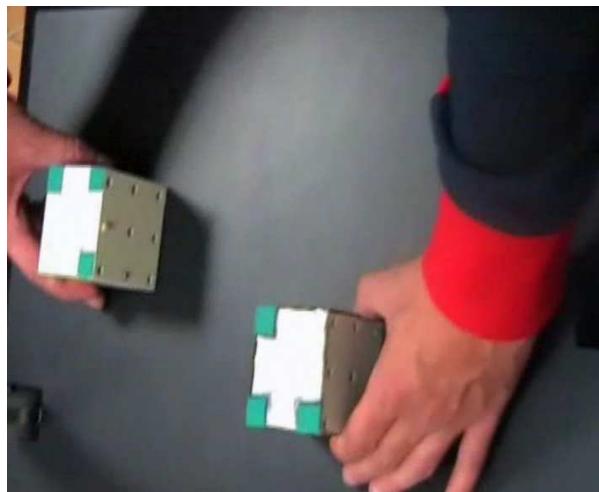
- **Brevie (ARTEC, 1998)**



<http://www.brevie.uni-bremen.de>

# Exemples

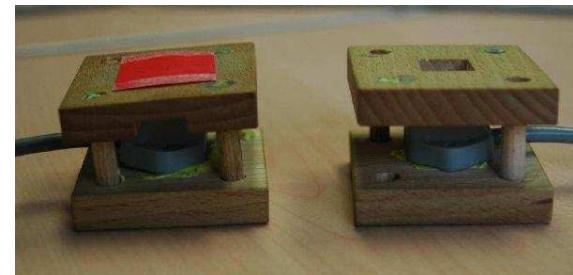
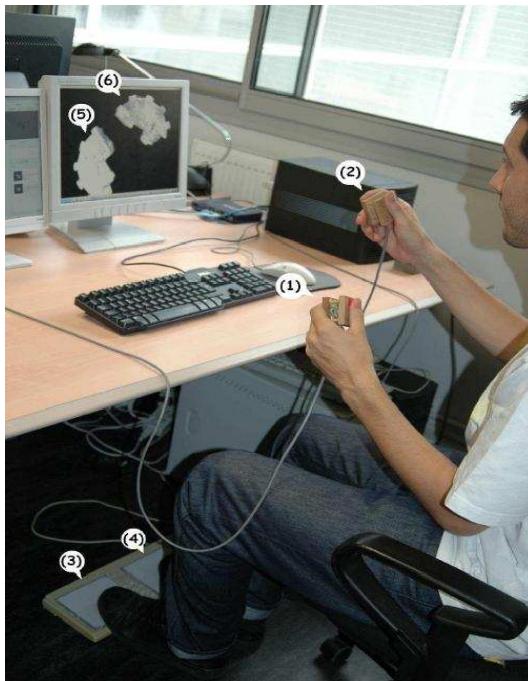
- **ESKUA (Garreau, ESTIA, 2002-2005)**



Garreau, L. and Couture N., Study of Tangible User Interface for handling tridimensionnal Objects. *Proceedings of Real World User Interfaces, PI'2003*, Udine, Italy, september 8-11 2003, pp. 64-68.

# Exemples

- ArcheoTUI (*ESTIA*, 2007)



Reuter, P., Rivière, G., Couture N., ArcheoTUI - A Tangible User Interface for the Virtual Reassembly of Fractured Archaeological Objects. *Proceedings of the 8th International Symposium on Virtual Reality, Archaeology and Cultural Heritage, VAST2007*, Brighton, UK, november 27-29 2007, pp. 15-22.

# Exemples

- **Nimio : ambiant awareness device**  
*(University of California, 2002)*



Brewer, J., Williams, A., Dourish, P., [Nimio: An Ambient Awareness Device. Demonstration at the European Conference on Computer-Supported Cooperative Work, ECSCW'05, september 18-22, 2005.](#)

# Exemples

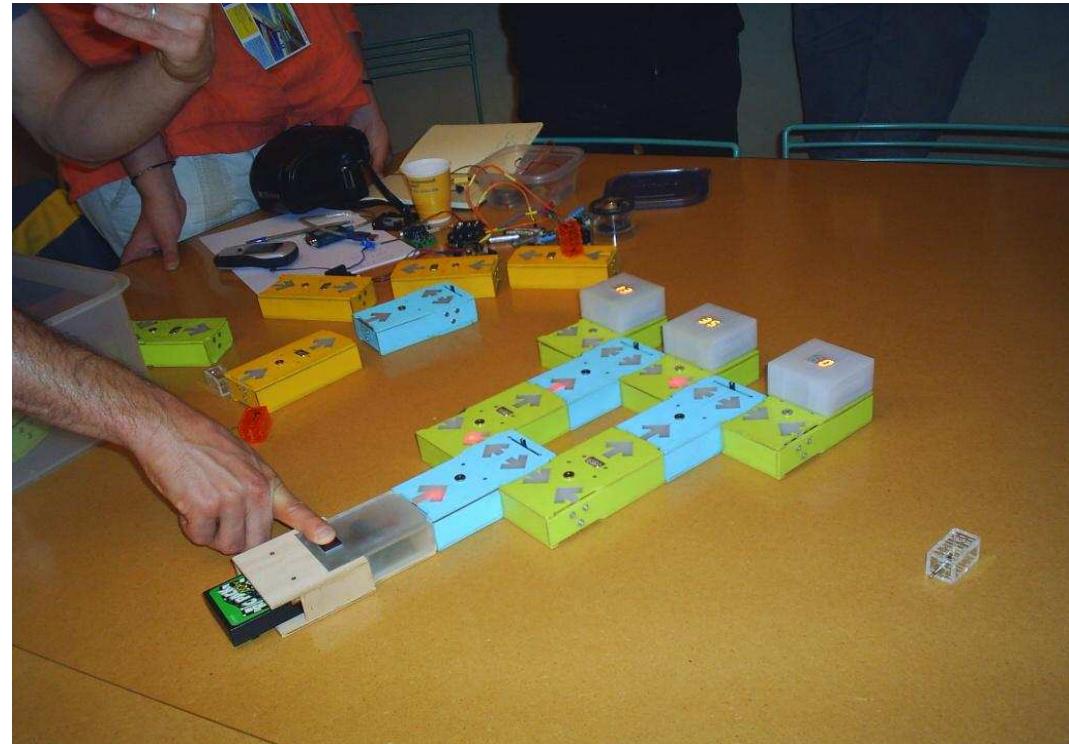
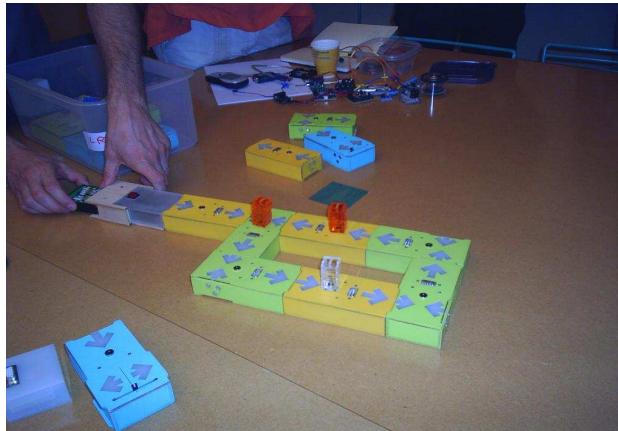
- PinWheels (*MIT, 2000*)



Ishii, H., Ren, S., and Freirewer, P., [Pinwheels: Visualizing Information Flow in an Architectural Space](#). In *Proc. CHI 2001*, march 31 - april 5, 2001, pp. 111-112.

# Exemples

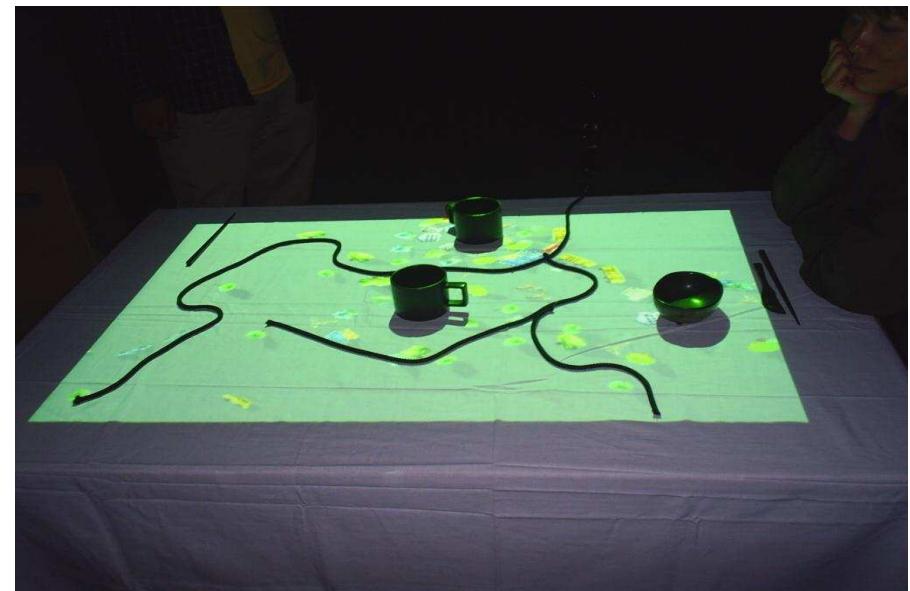
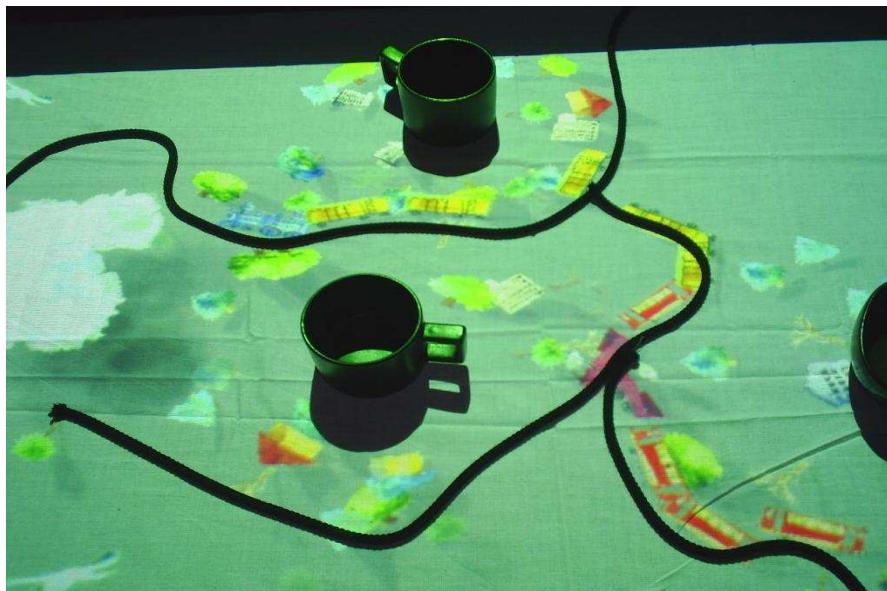
- **Flow Blocks (Oren Zuckerman, MIT)**



Tutorial Prototyping Tangible  
Interfaces, ECSCW'05

# Exemples

- **Diorama Table (Japan Electronic College)**



Takahashi K, Sasada S. [Diorama table](#). In MM'05: Proceedings of the 13th annual ACM international conference on Multimedia, ACM Press (2005) pp. 1077-1078.

# Exemples

- **Sound Flakes (Tokyo Denki University)**



Animations, Laval Virtual 2005

# Plan

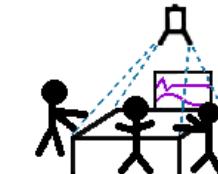
Exemples de TUI



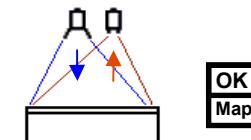
Formalisation



TUI + Tabletop

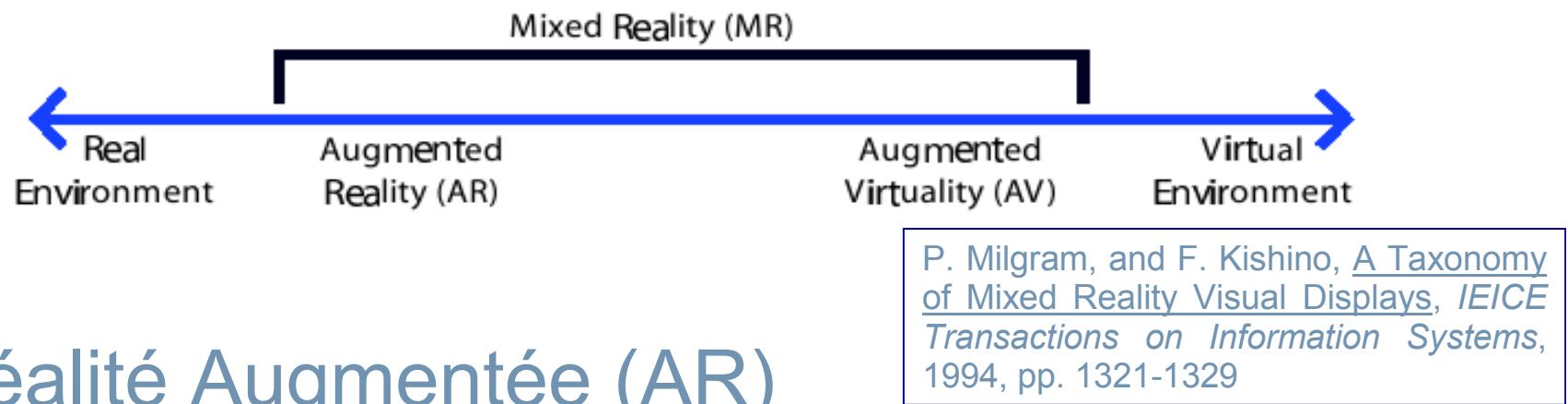


Plateforme de GeoTUI



# Définitions

- Réalité Mixte (MR)
  - Fusion des mondes physiques et numériques



- Réalité Augmentée (AR)
  - Une “quantité” de virtuel est ajoutée au réel.
  - Le but est d'augmenter l'interaction avec le monde réel grâce à l'ordinateur.

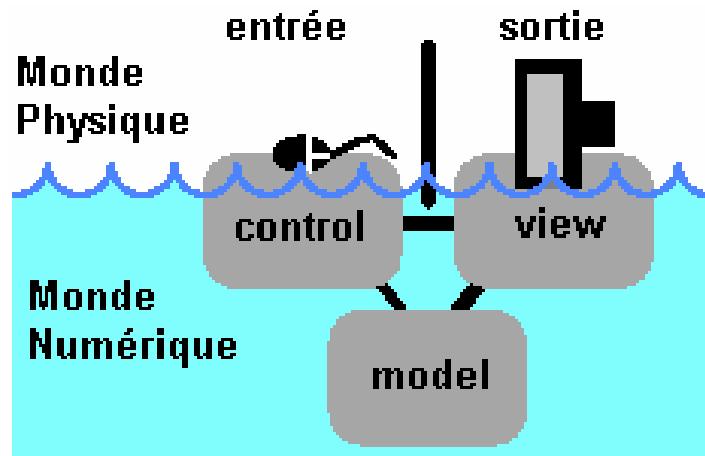
# Définitions

- Virtualité Augmentée (AV)
  - Une “quantité” de réel est ajoutée au virtuel
  - Le but est d'augmenter l'interaction avec l'ordinateur à l'aide d'objets et d'actions dans le monde réel
- Interfaces Tangibles
  - « *give physical form to digital information, employing physical artifacts both as representations and controls for computational media* »

B. Ullmer and H. Ishii, [Emerging frameworks for tangible user interfaces](#), IBM Systems Journal, 2000, pp. 915-931.

# Modèles

## Interface Graphique

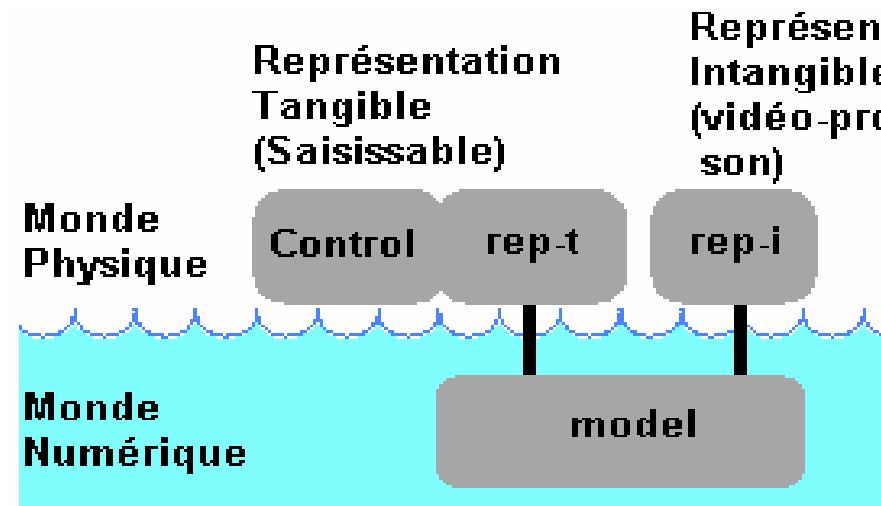


MVC (1980)

**MVC** : Model View Control

**MCRit** : Model Control Representation (tangible-intangible)  
(originellement appelé MCRpd)

## Interface Tangible



MCRit (2001)

Ullmer, B. and Ishii, H., Emerging Frameworks for Tangible User Interfaces.  
*Human-Computer Interaction in the New Millennium*, august 2001, pp. 579-601.

# Plan

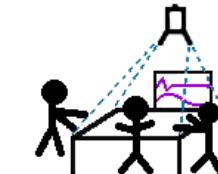
Exemples de TUI



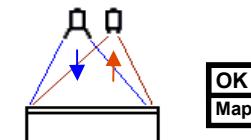
Formalisation



TUI + Tabletop

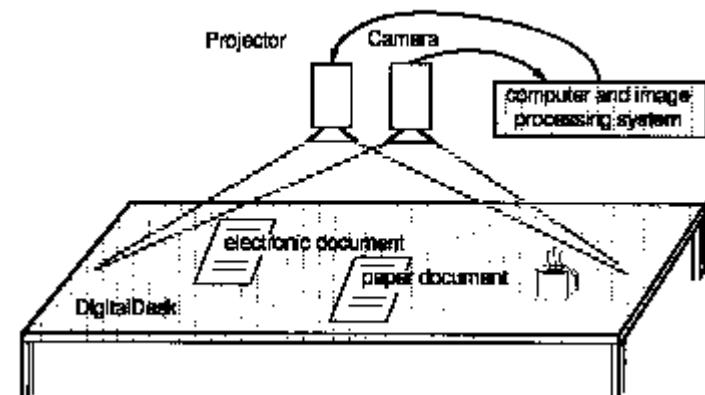
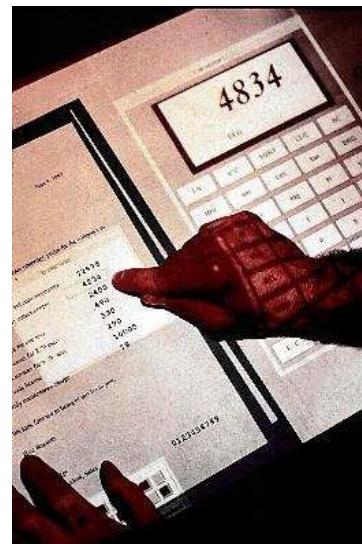


Plateforme de GeoTUI



# Les origines

- Digital Desk (*Wellner, 1993*)



Wellner, P. [Interacting with paper on the DigitalDesk, Communications of the ACM 36, 7 \(1993\), pp. 86-96.](#)

# Un produit commercialisé

- **MS Surface (Janvier 2007)**



<http://www.microsoft.com/surface>

# Exemples

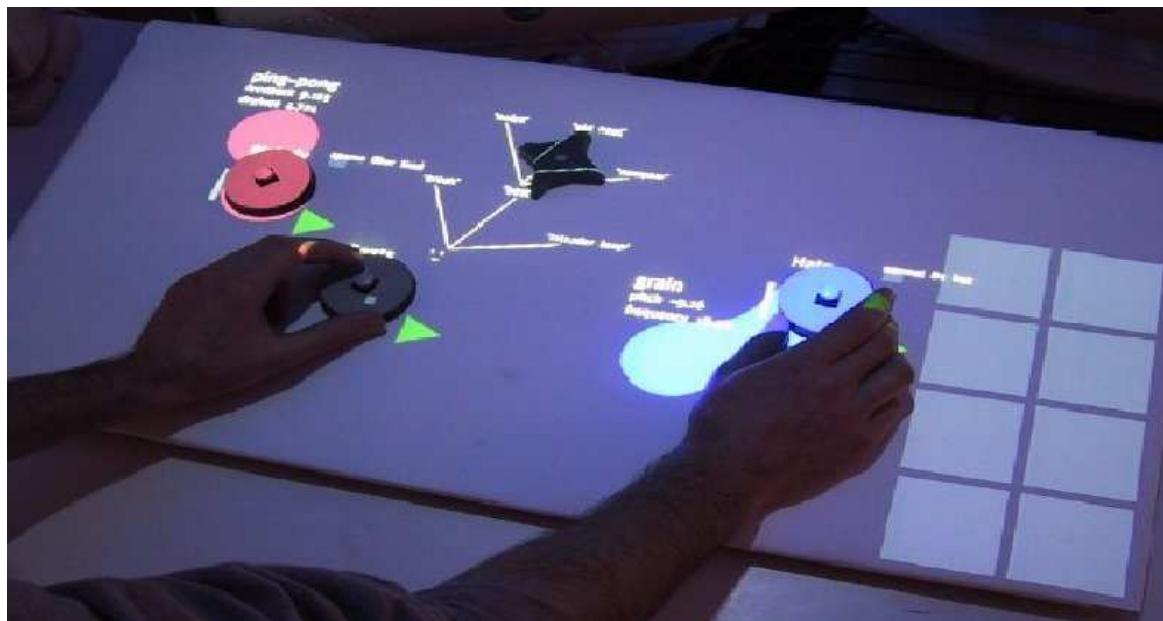
- **Bricks** (*MIT, 1995*)



Fitzmaurice, G., Ishii, H. and Buxton, W. [Bricks: Laying the Foundations for Graspable User Interfaces](#). In *Proc. CHI'95*, pp. 442-449.

# Exemples

- **AudioPad (SenseTable, MIT, 2002)**

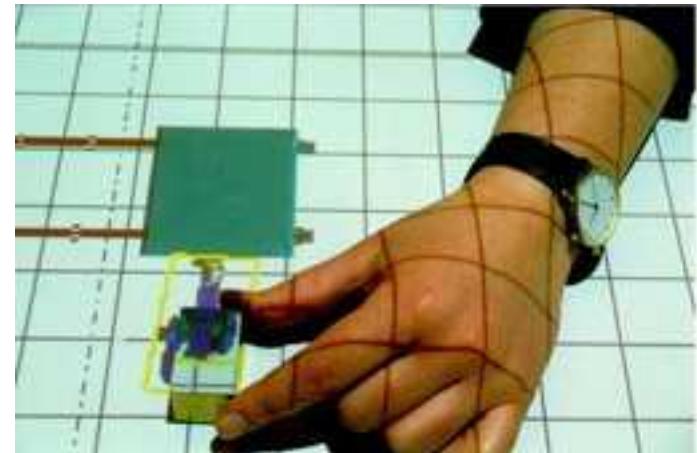


## Vidéo

Patten, J., Recht, B. and Ishii, H. [Audiopad: A Tag-based Interface for Musical Performance](#). In *proceedings of NIME02*, National University of Singapore (2002), pp. 11-16.

# Exemples

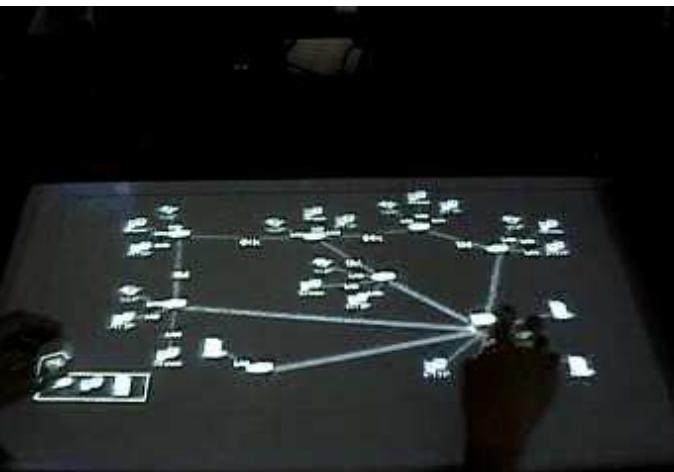
- **Built-IT (1997)**



Fjeld, M., Bichsel, M. and Rauterberg, M. BUILD-IT: An Intuitive Design Tool Based on Direct Object Manipulation. *In proceedings of GW'97*, pp. 297-308.

# Exemples

- IP Design Workbench (*SenseTable, MIT, 03*)



Kobayashi, K., Hirano, M., Narita, A. and Ishii, H., [A Tangible Interface for IP Network Simulation](#). In Proc. CHI 2003, april 5-10, 2003, pp. 800-801.

# Exemples

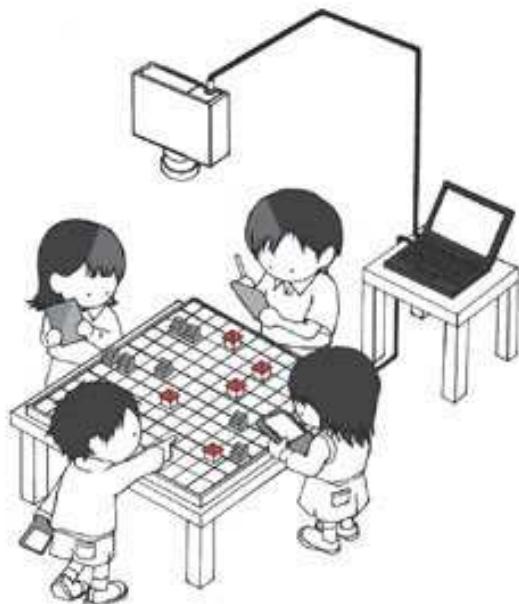
- **Disaster simulation (SenseTable, MIT, 2006)**



K Kobayashi, A Narita, M Hirano, I Kase,  
S Tsuchida, T Omi, T Kakizaki and T  
Hosokawa, [Collaborative simulation](#)  
[interface for planning disaster measures](#),  
In *Proc. CHI'06*, pp. 977-982.

# Exemples

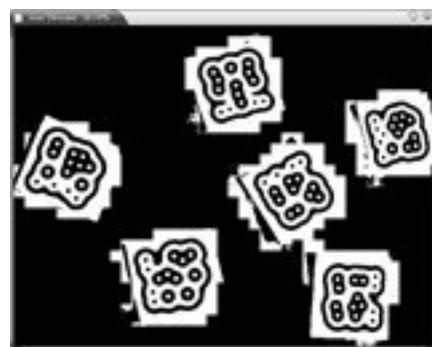
- **Caretta** (*Tokyo University, 2004*)



Sugimoto M, Hosoi K, Hashizume H. [Caretta: a system for supporting face-to-face collaboration by integrating personal and shared spaces](#). In *Proc. CHI '04*, pp. 41-48.

# Exemples

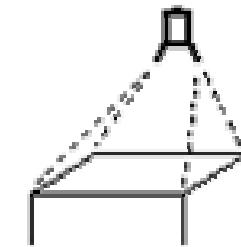
- **ReacTable**



Jorda S, Geiger G, Alonso M, Kaltenbrunner M. The reacTable: Exploring the Synergy between Live Music Performance and Tabletop Tangible Interfaces. In *TEI '07: Proceedings of the 1st international conference on Tangible and embedded interaction*, ACM Press (2007) pp. 139-146.

# Intérêts

- Aspect Tabletop
  - Conditions de travail connues
  - Travail en collaboration co-présente
  - Interaction horizontale
  - Travail quotidien
- Aspect TUI
  - Simplifier l'interaction
  - Objets du quotidien
  - Partager des objets



# Plan

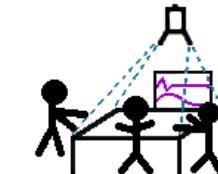
Exemples de TUI



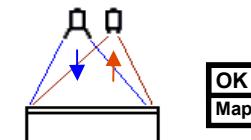
Formalisation



TUI + Tabletop

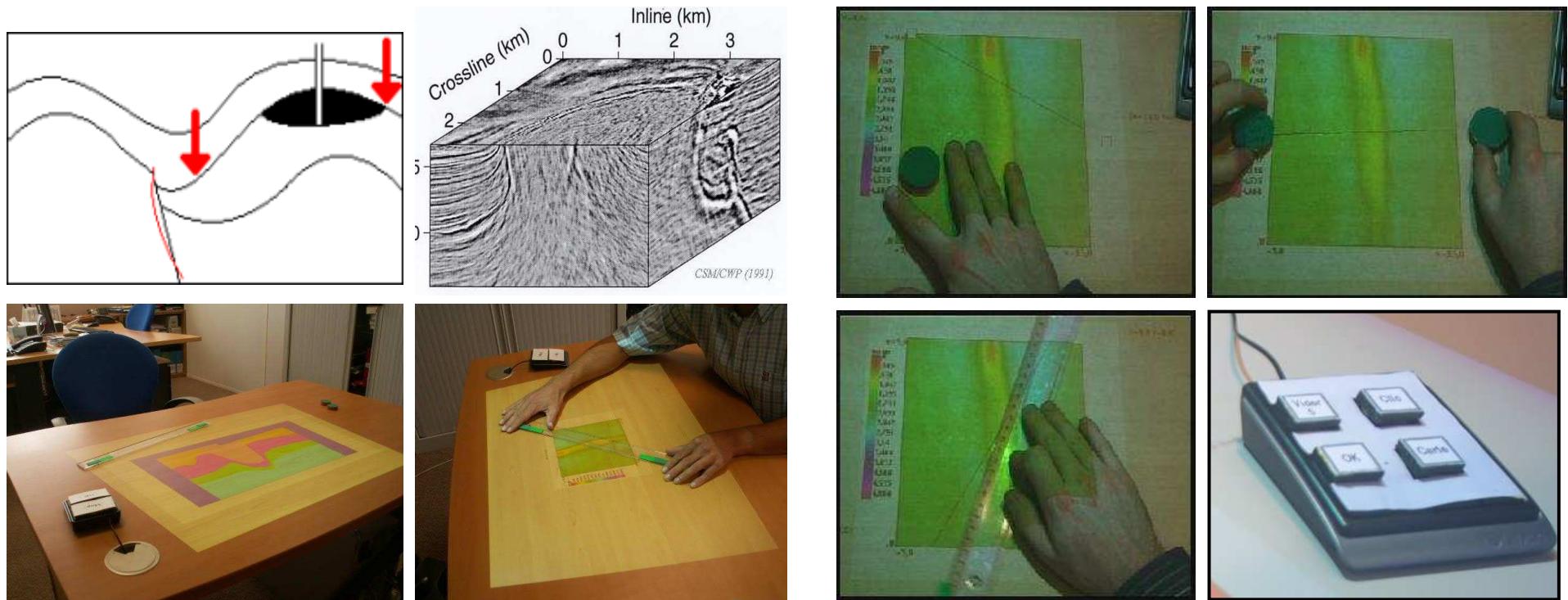


Plateforme de GeoTUI

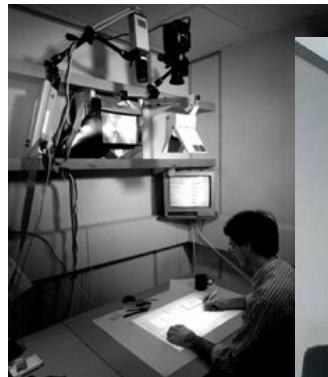
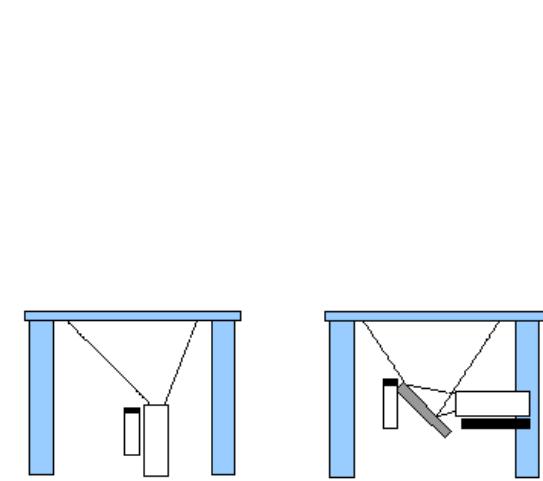
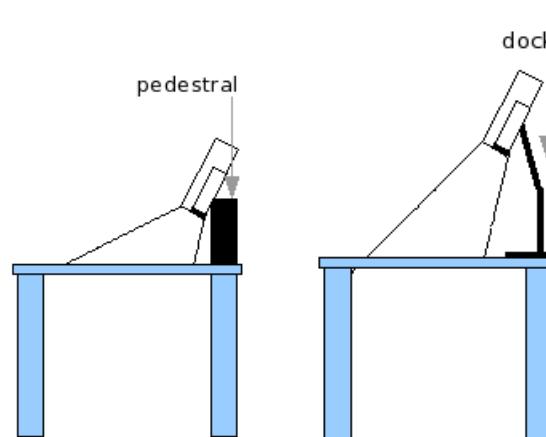
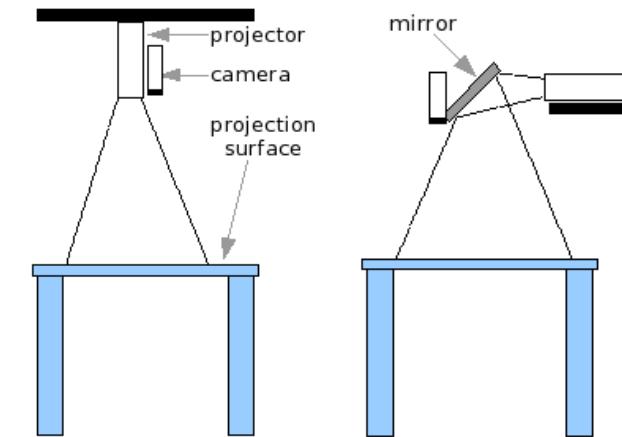


# L'interface GeoTUI

- Une interface tangible pour les géosciences



# Tabletops avec Vision/Projection



Digital Desk



Virtual Design  
Workbench



Play  
Anywhere

DockLamp



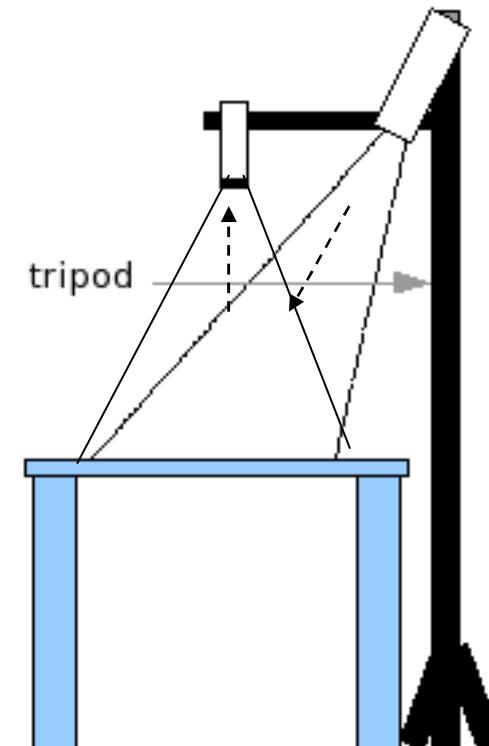
ReacTable



MS Surface

# Conception de GeoTUI

- Contraintes
  - Mobile
  - Faible coût
- Choix
  - Vision par ordinateur
  - Trépied
  - Matériel ordinaire
  - Table sur place

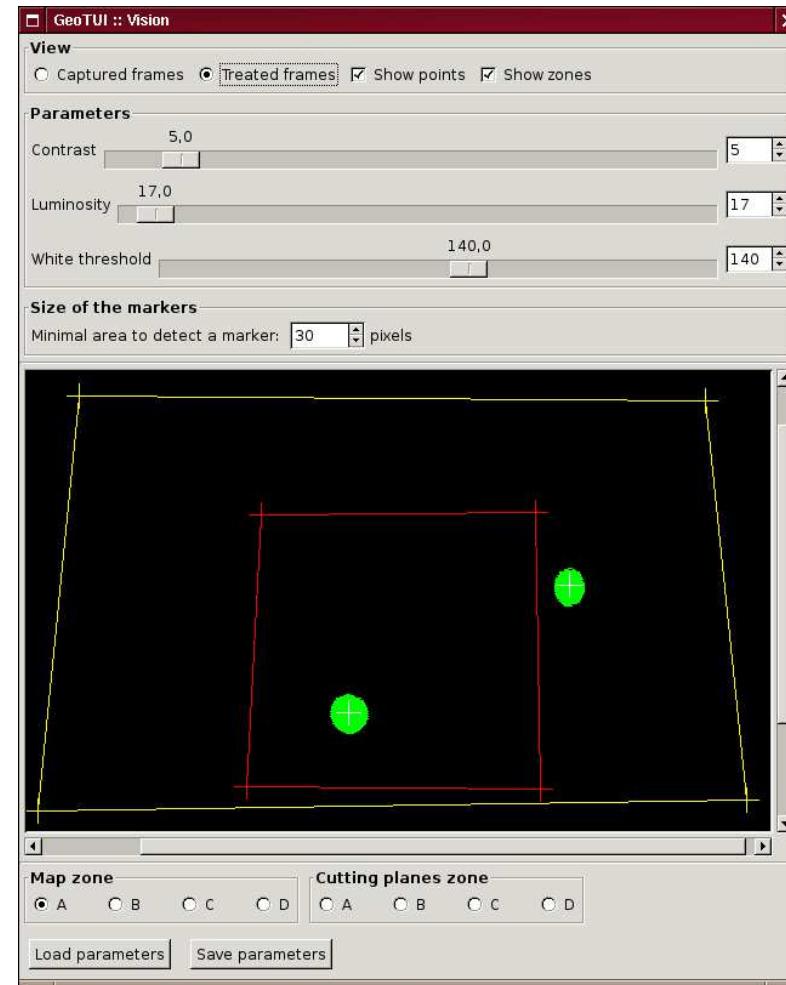
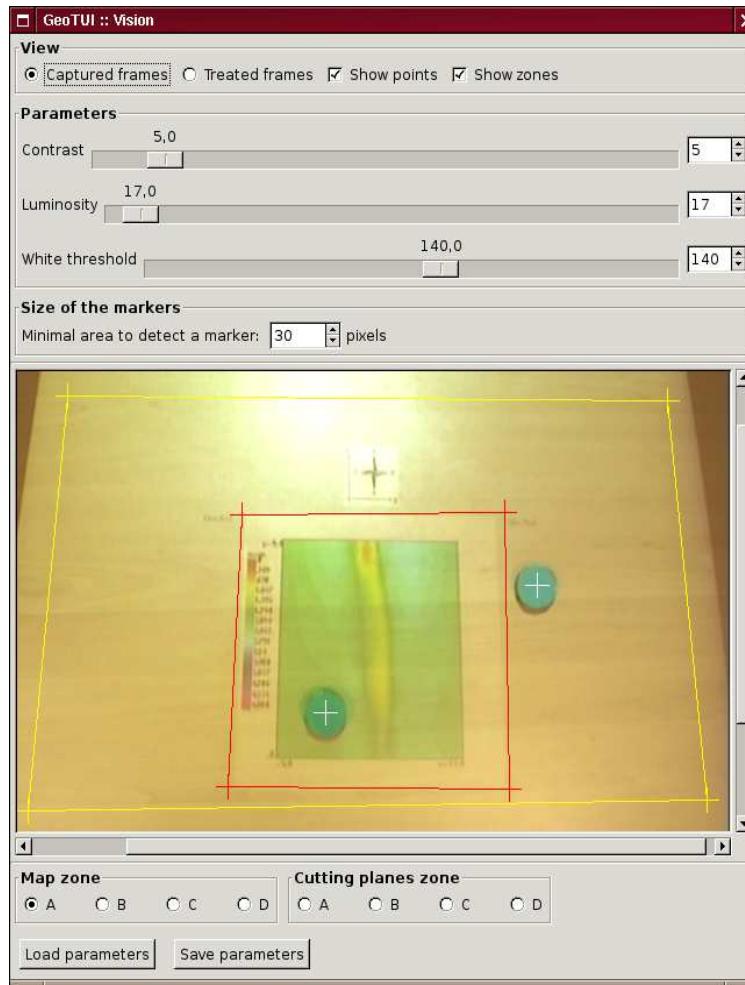


# Matériel

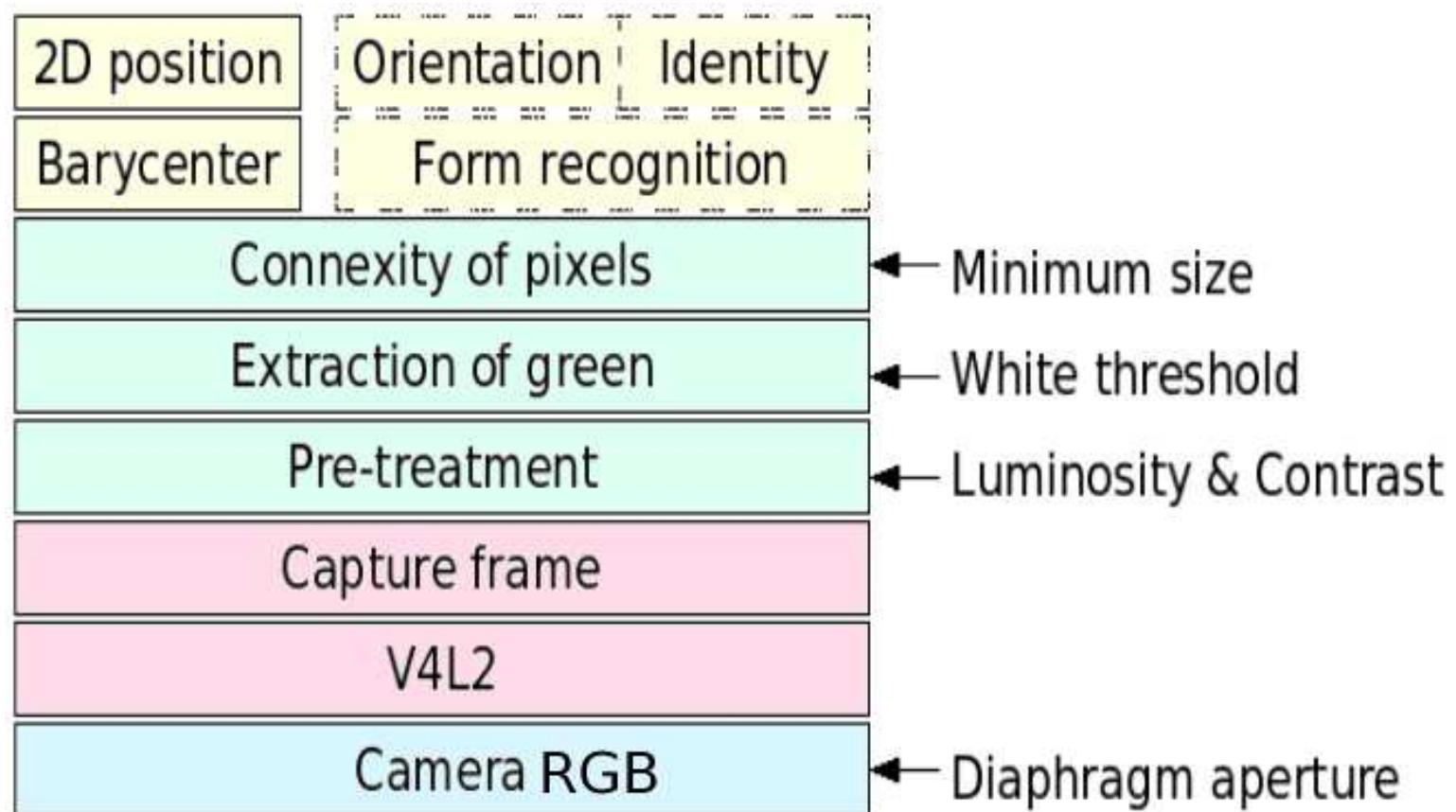


- Trépied : SHOWTEC Alu Stand Double T-Bar
- Vidéo-projecteur : EPSON EMP7200
- Caméra RGB : SONY XC-555P
- Boîtier : Labtec USB Number Pad

# Détection des objets



# Procédure de vision



Garreau L. Elaboration d'une interface tangible pour l'assemblage en CAO. Thèse de l'Université Bordeaux 1, Septembre 2005.

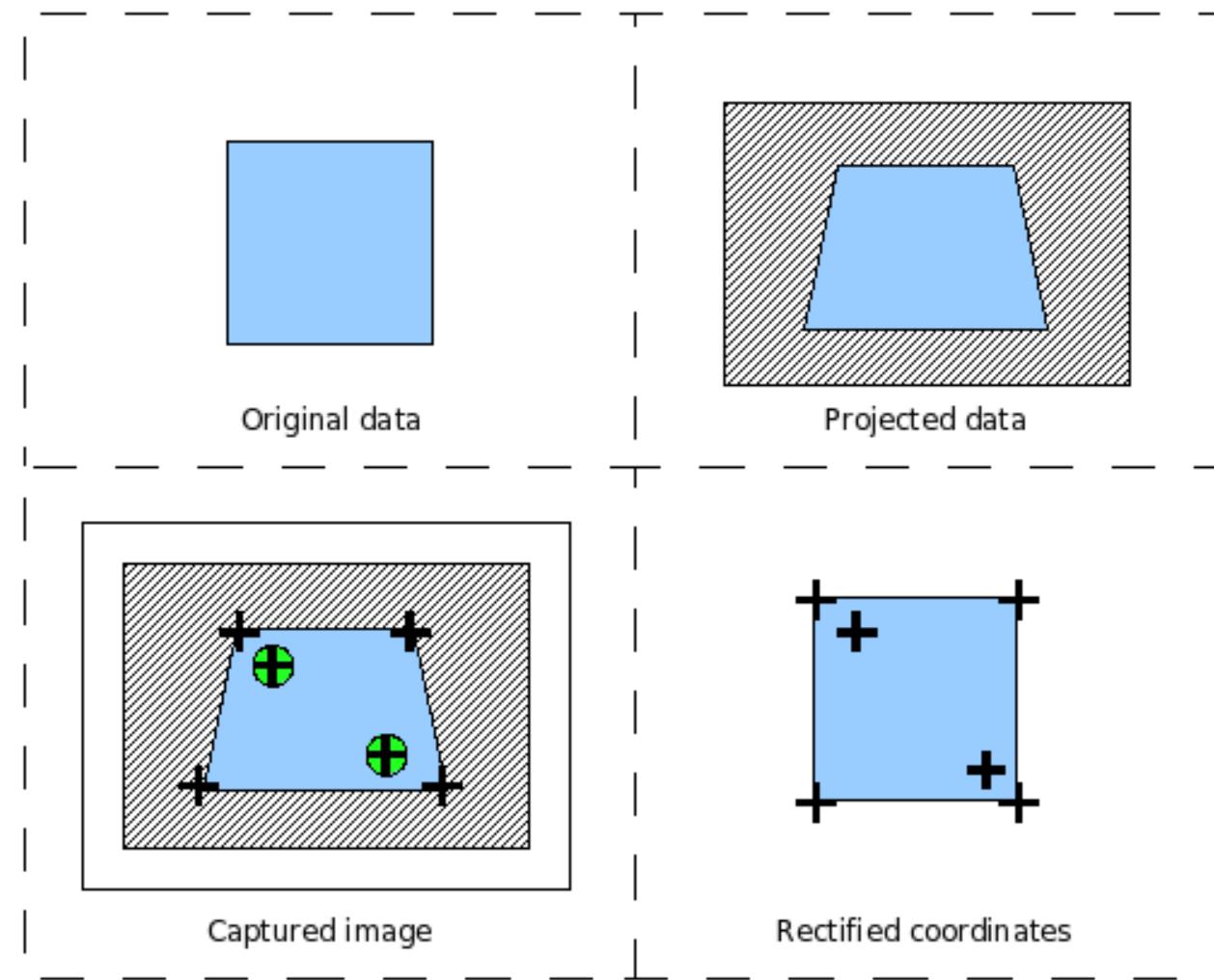
# Traitement d'image

- L'algorithme d'extraction de vert

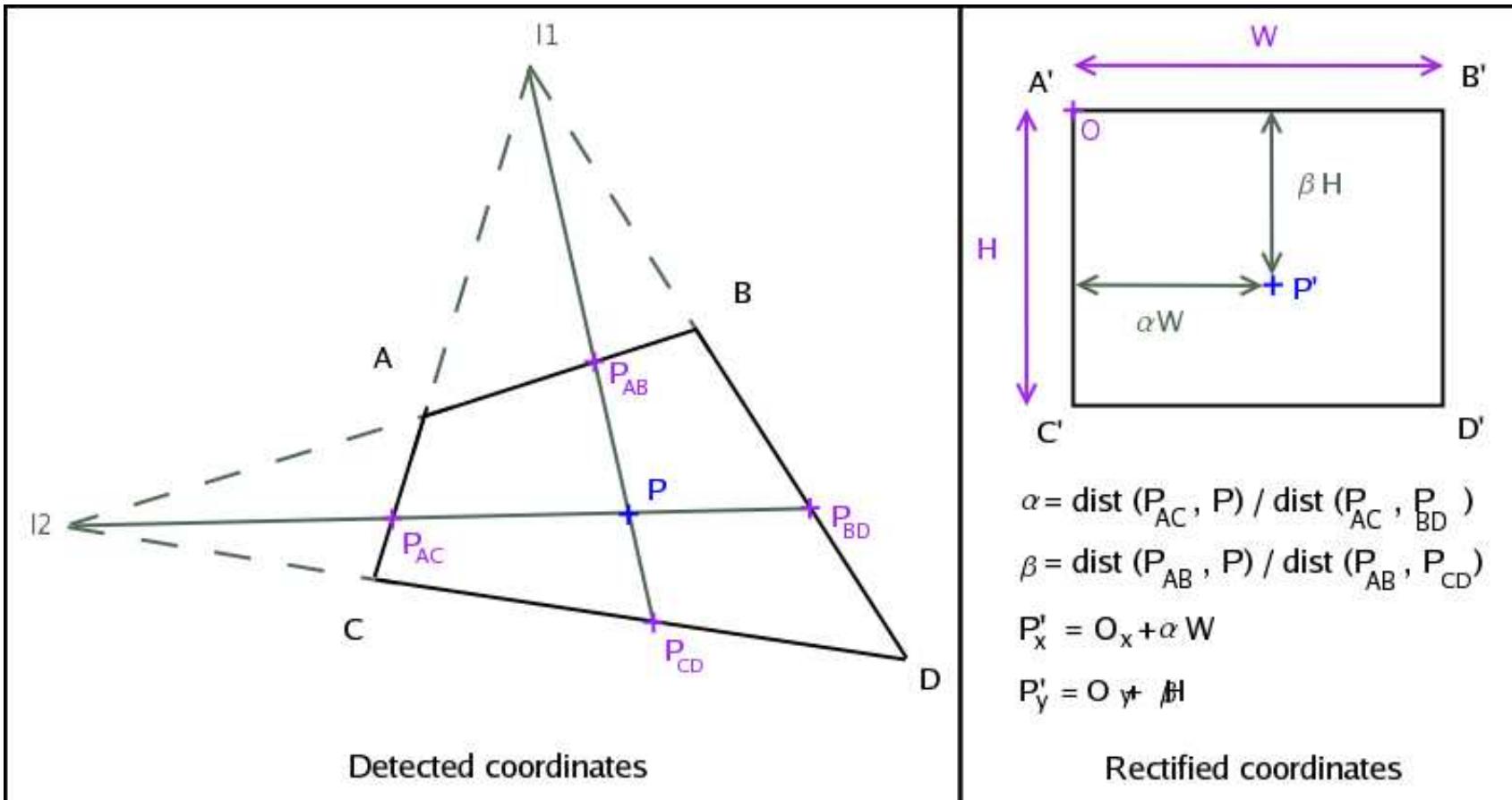
```
Procedure ExtractGreen (inout I: imageRGB, in WhiteThreshold: integer)
Variable
    T: integer
    P: pixelRGB
Begin
    T ← WhiteThreshold - 100
    ForEach P Of I Do
        If P.Green > 70 and P.Green-T > R and P.Green-T/2 > P.Blue Then
            P ← (0,255,0) // Set the pixel in green
        Else
            P ← (0,0,0) // Set the pixel in black
        EndIf
    EndForEach
End
```

Garreau L. Elaboration d'une interface tangible pour l'assemblage en CAO. Thèse de l'Université Bordeaux 1, Septembre 2005.

# Déformation en trapèze



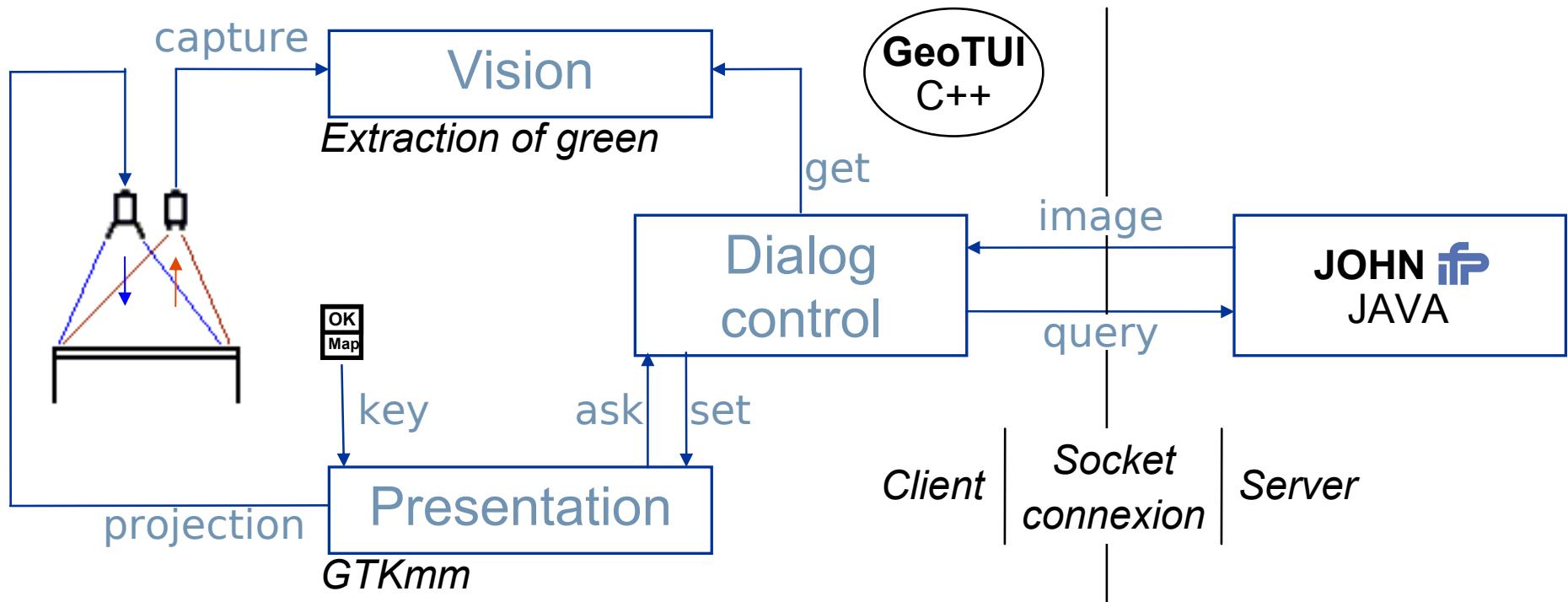
# Réajustement des coordonées



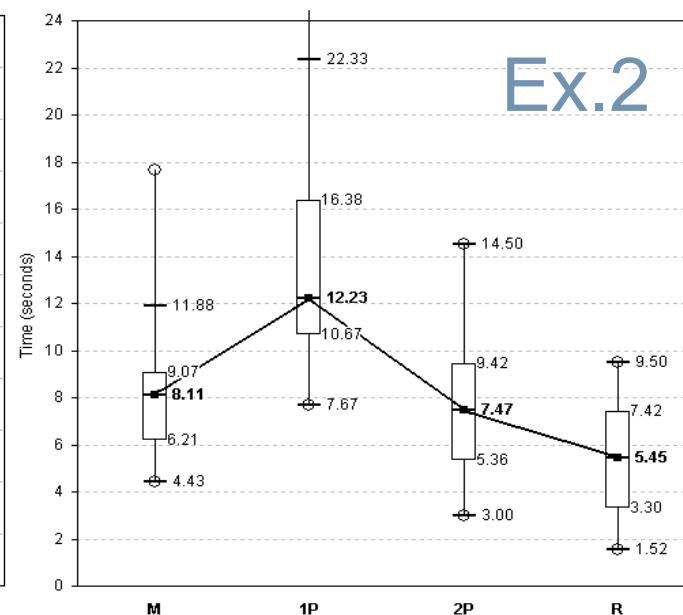
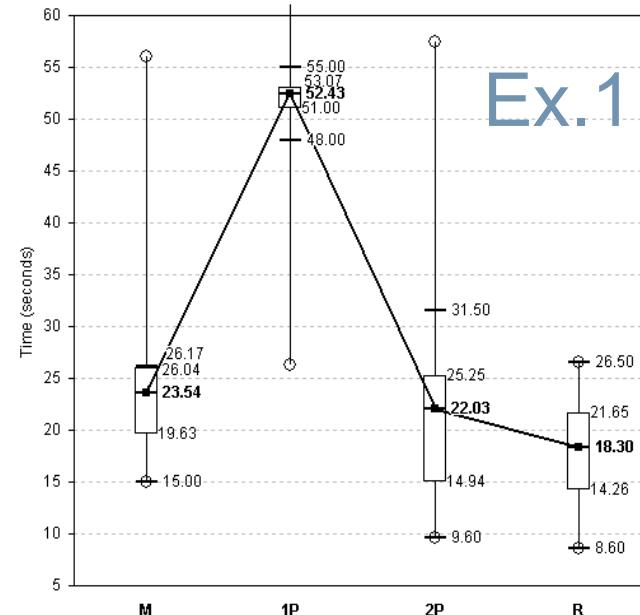
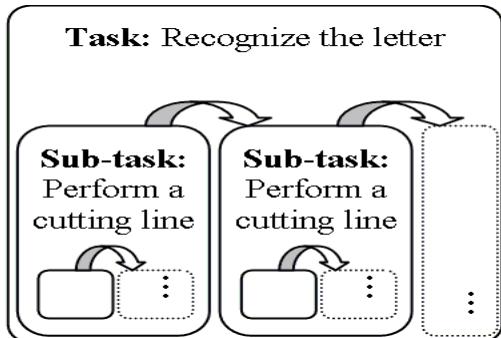
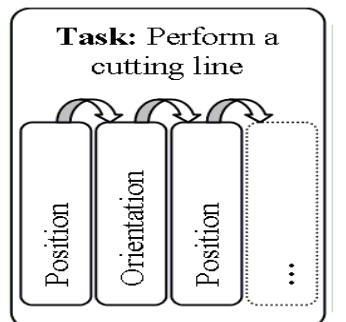
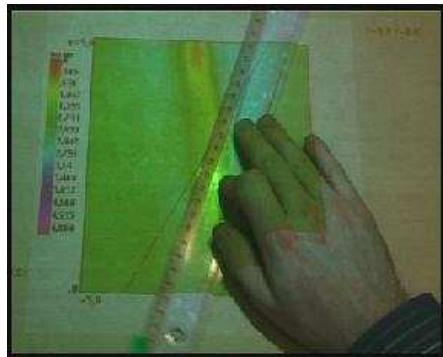
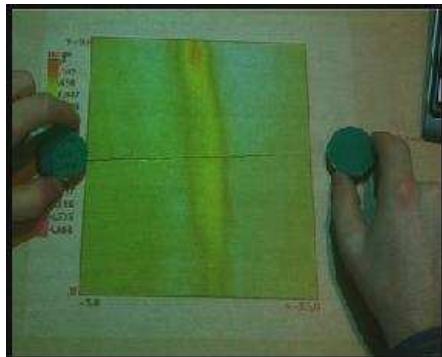
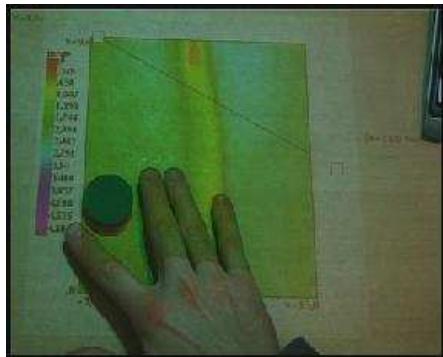
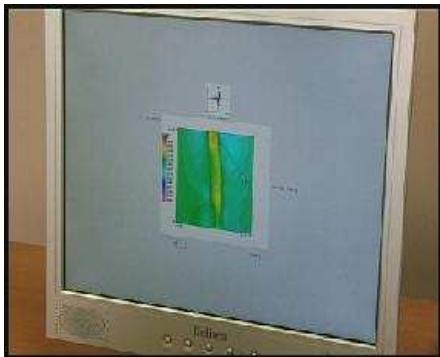
<http://sourceforge.net/projects/rectify-coords/>

# Architecture logicielle

- Substitution de l'interface graphique



# Etudes utilisateurs avec la plateforme



# Definitions

- Characterization of input devices

- Time-multiplexed input

*« one device controls different functions at different points in time »*



- Space-multiplexed input

*« each function to be controlled has a dedicated transducer »*



**Fitzmaurice, Ishii, Buxton, 95,96,97**

# Definitions

- Characterization of input devices
  - Generic form / Specialized form
 

*« specialized form when it roughly matches the shape and manipulation characteristics of the logical controller »*
- Cutting line selection task

Fitzmaurice,  
Buxton, 96, 97

		Multiplex	Form
GUI	Mouse	<i>Time</i>	<i>Generic</i>
TUI	1-Puck	<i>Time</i>	<i>Generic</i>
	2-Puck	<i>Space</i>	<i>Generic</i>
	Ruler	<i>Space</i>	<i>Specialized</i>

# Fitzmaurice's hypothesis

- Manipulating physical/logical
  - (H1) Multiplex: Space > Time
  - (H2) Form: Specialized > Generic (in space-multiplex conditions)

	H1	H2
Match a series of target <b>Fitzmaurice 96 Chap 6.1</b>	✓	✗
Ex1: Perform a series of six cutting planes	✓	✗
Ex2: Recognize a letter	✓	✓

**Spec. ~ Gen.**

$R \sim 2P$   
5% speedup

$R > 2P$  18% speedup  
133% performance gain

# Specialized vs. generic devices

*« Just as the additional physical constraints in the tower of Hanoi/oranges/tea cups task helped the user with mental problem solving, the physical constraints in the ruler and stretchable square help the users physically maintain these relationships that exists between the dimensions of the virtual and real rectangle being drawn »*

**Fitzmaurice 96  
Chap 6.1**

- A series of simple tasks ✗
  - Match a series of target
  - Perform a series of six cutting planes
- A composed task ✓
  - Recognize the letter hidden in the cube

# *Questions*

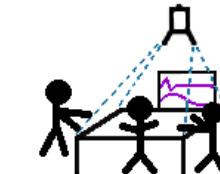
**Exemples de TUI**



**Formalisation**



**TUI + Tabletop**



**Plateforme de GeoTUI**

