GeoTUI

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GeoTUI:
A Tangible User Interface for Geoscience

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ESTIA, LaBRI, INRIA

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Conference on Tangible and Embedded Interaction
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GeoTUI

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Plan

- Need of a new kind of interaction
- GeoTUI
- User evaluation of 4 interactions
- Fitzmaurice's hypothesis

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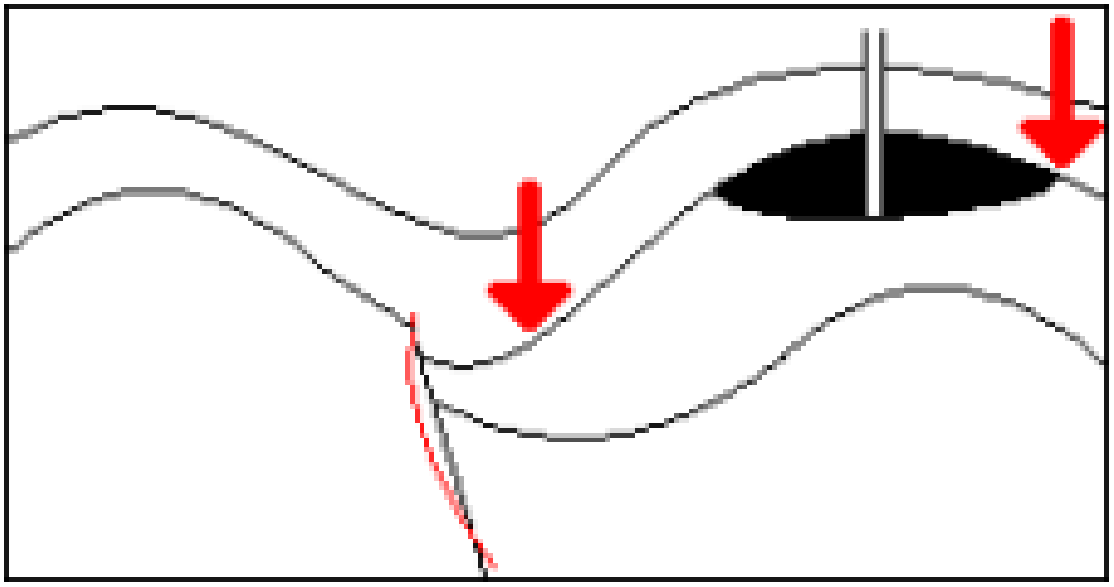
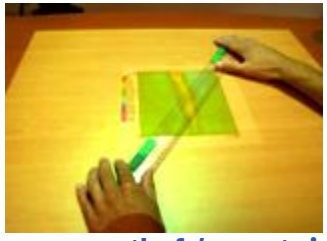
The search of hydrocarbons

- Deciding the construction of an oil well





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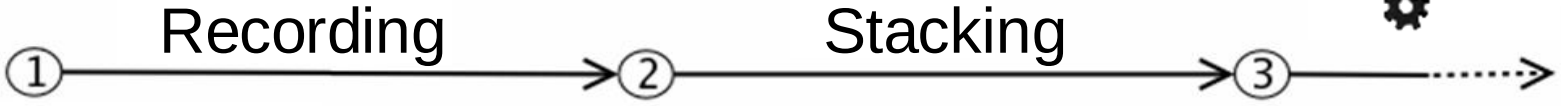
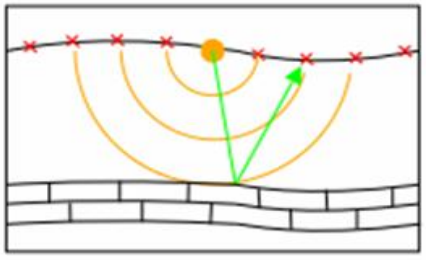
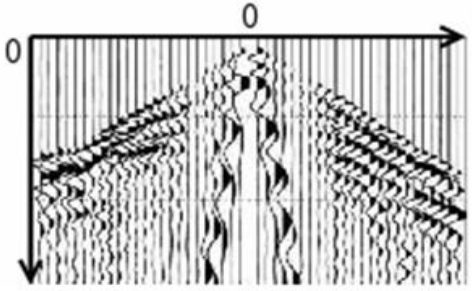
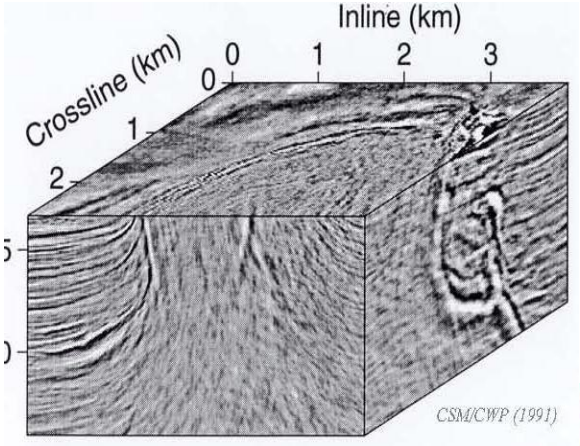
Compute a model

- Seismic acquisition









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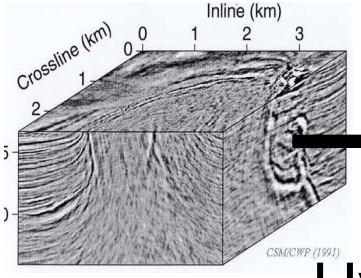
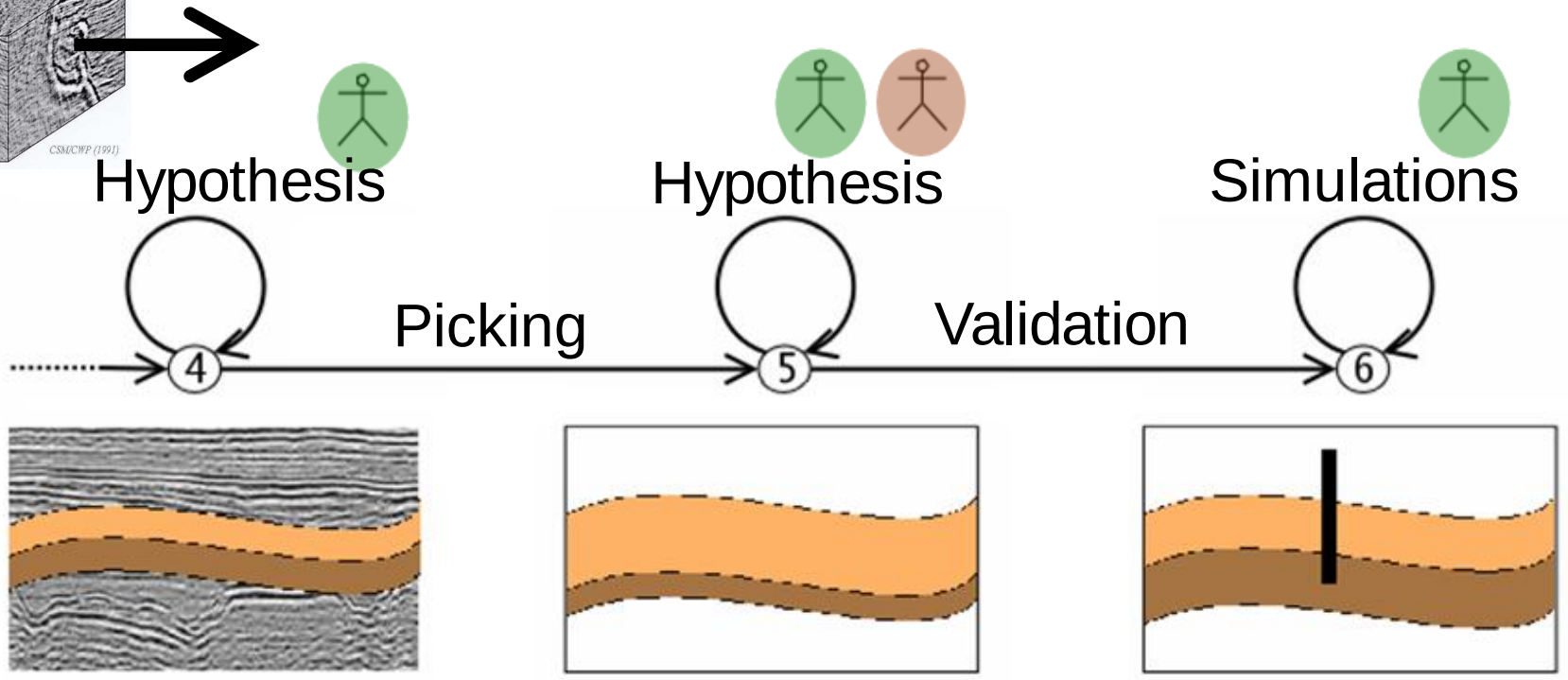
Compute a model

- Validation of hypothesis





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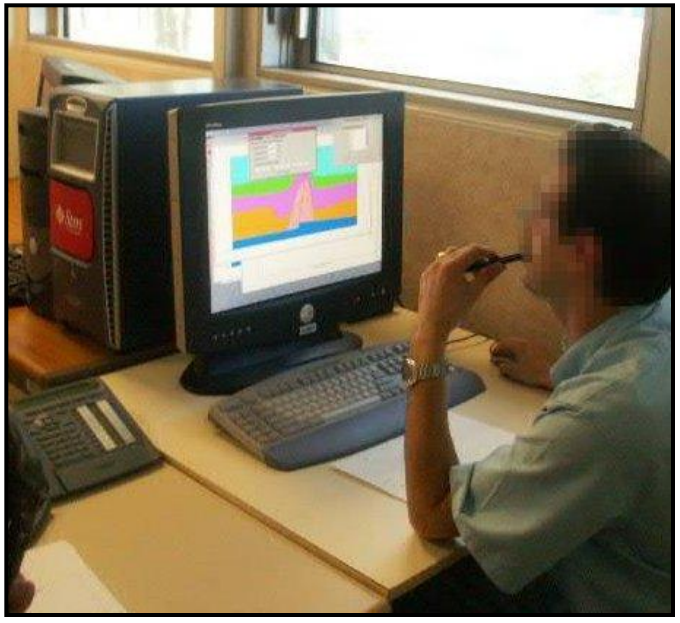
The need of a new interaction

- GUI for geological simulation software
  - Difficulty to interact with data
  - Difficulty to collaborate in co-presence



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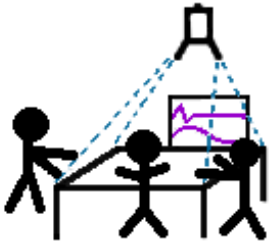
A new mixed reality system

- Tangible UI

- on a TableTop vision-projection system

dedicated to geoscience



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Previous works

- Seminal works

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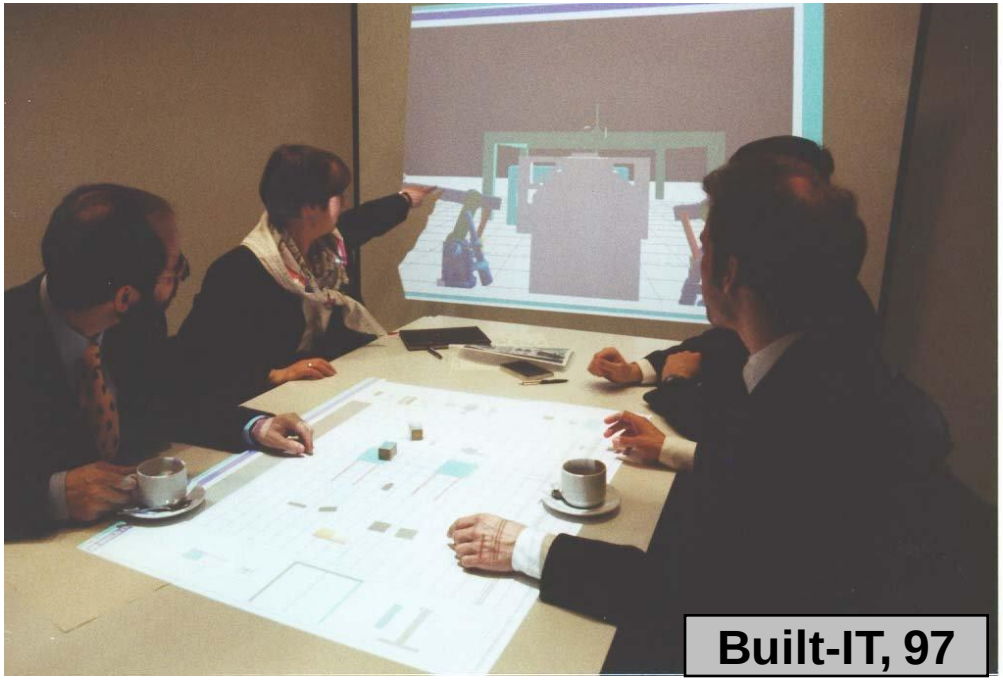
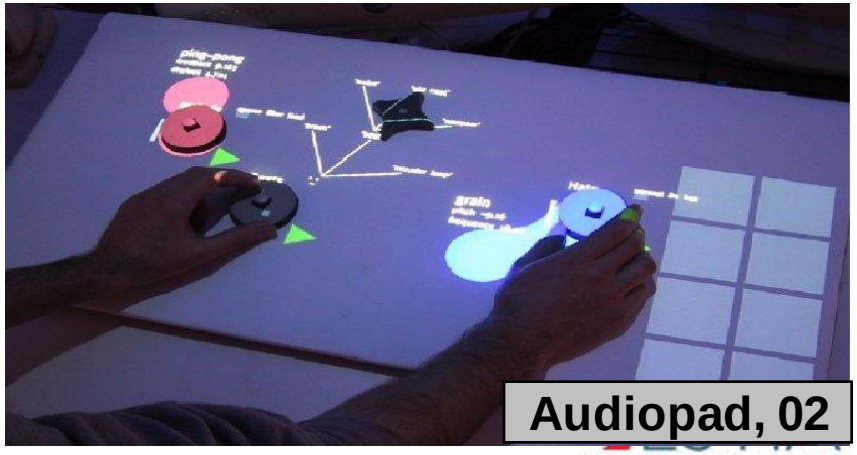
Previous works

- Mixed Tabletop & TUI





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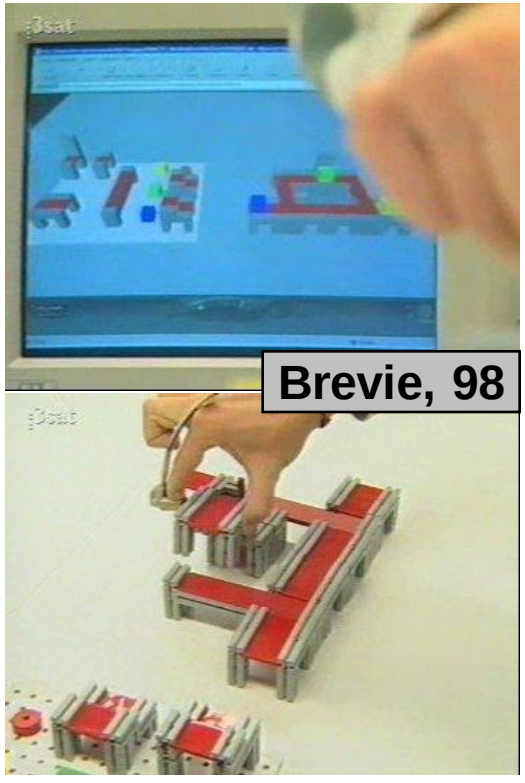
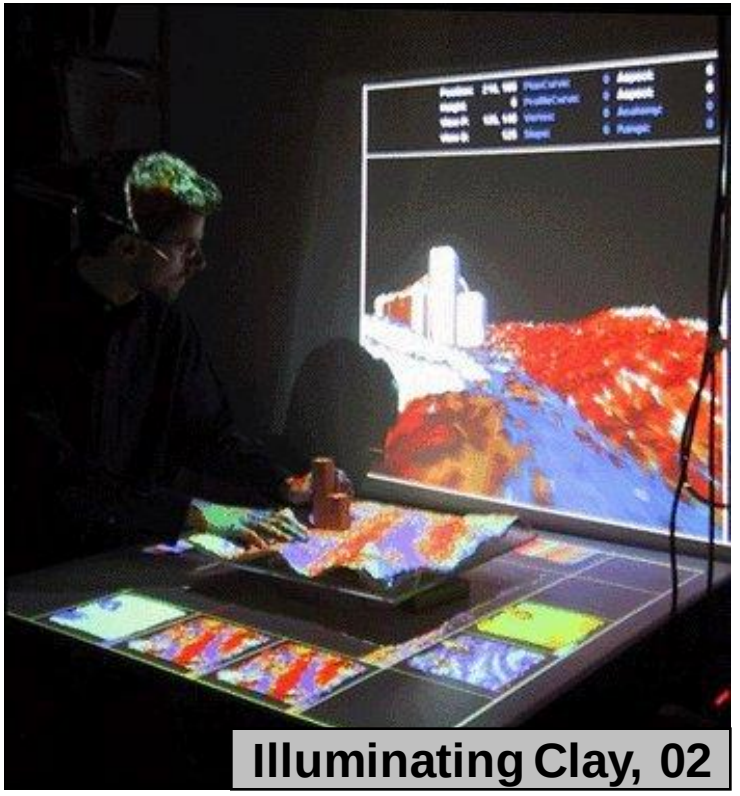
Previous works

- Application fields



Brevie, 98

Virtual Design Workbench, 03



Illuminating Clay, 02

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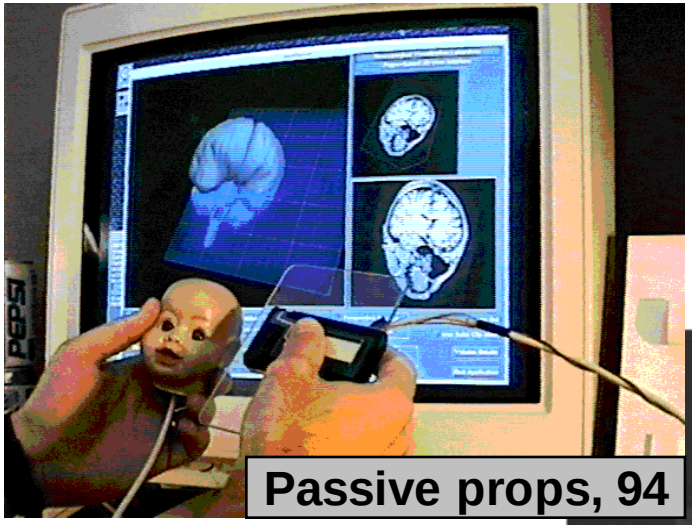
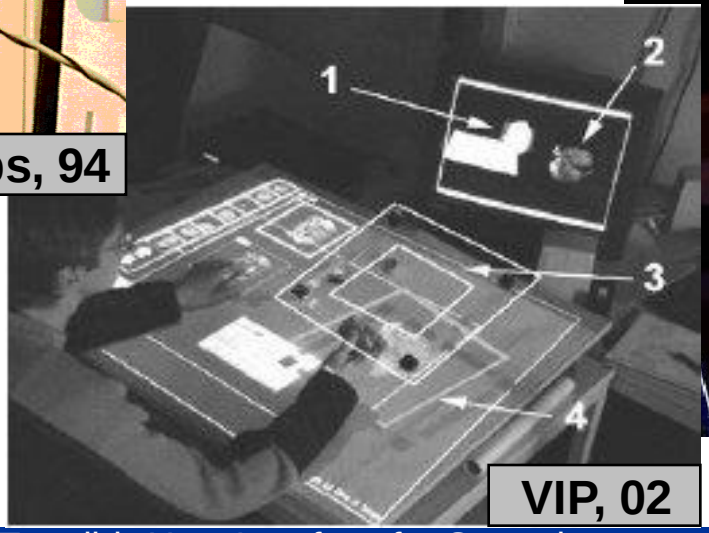
Previous works

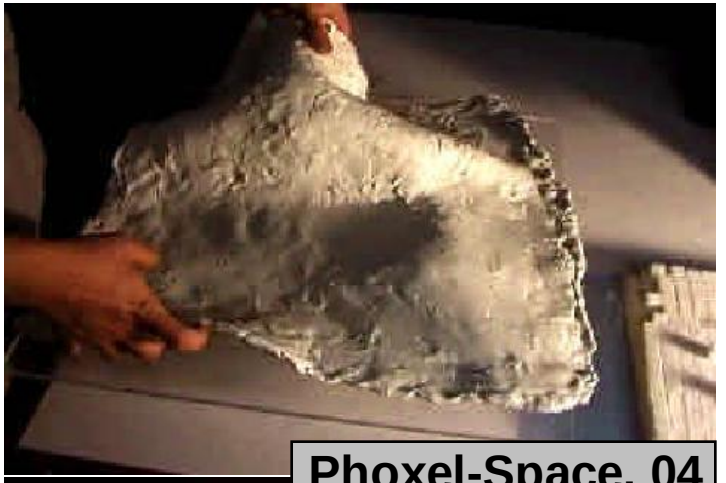
- Slices in 3D data



Passive props, 94



VIP, 02



Phoxel-Space, 04

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Our specific constraints

- The requirements for geoscience
  - Interact around a TableTop
  - Action and perception space must coincide
  - Selection of vertical cutting planes only

Norman 1988

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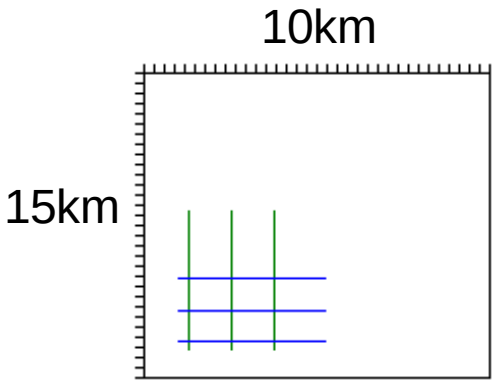
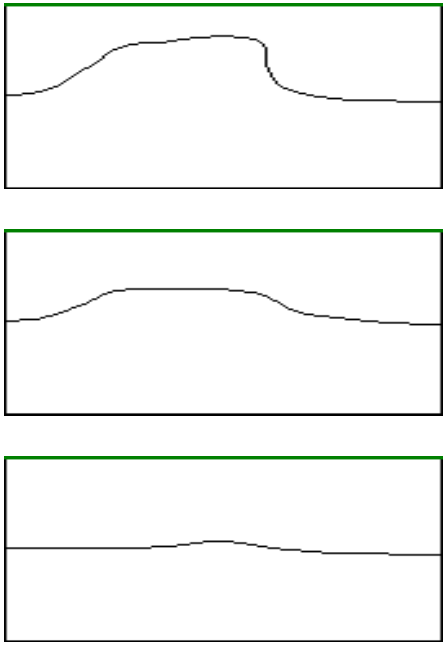
Focus on a key task

- Cutting plane selection task

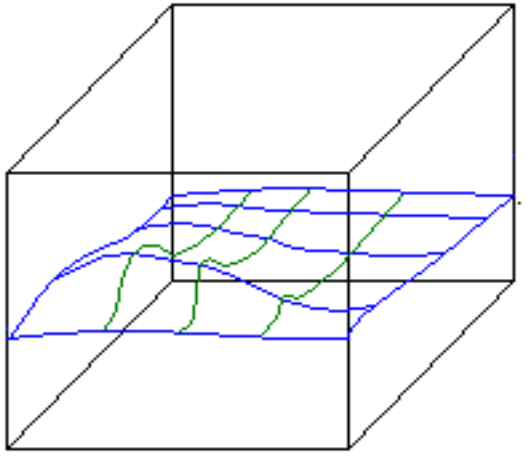
Topview map



Cutting planes



Mental representation



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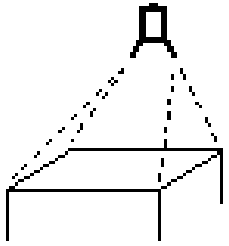
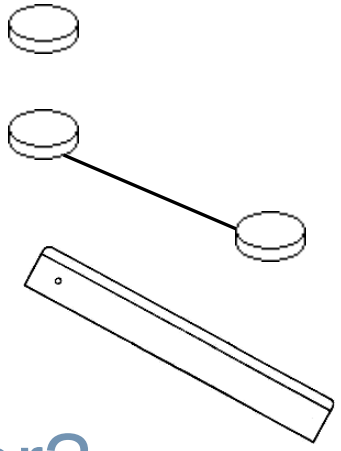
Four interactions

- Cutting line selection task from a top map



  - The mouse *(M)*
  - The one-puck prop *(1P)*
  - The two-puck prop *(2P)*
  - The ruler prop *(R)*



- Is one interaction better than another?

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The action of validation

- A button box

"People would be better served if we would return to control through physical objects, to real knobs, sliders, buttons, to simpler, more concrete objects and actions"

Norman 1999

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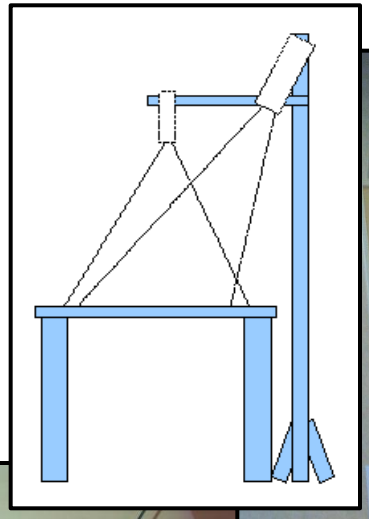
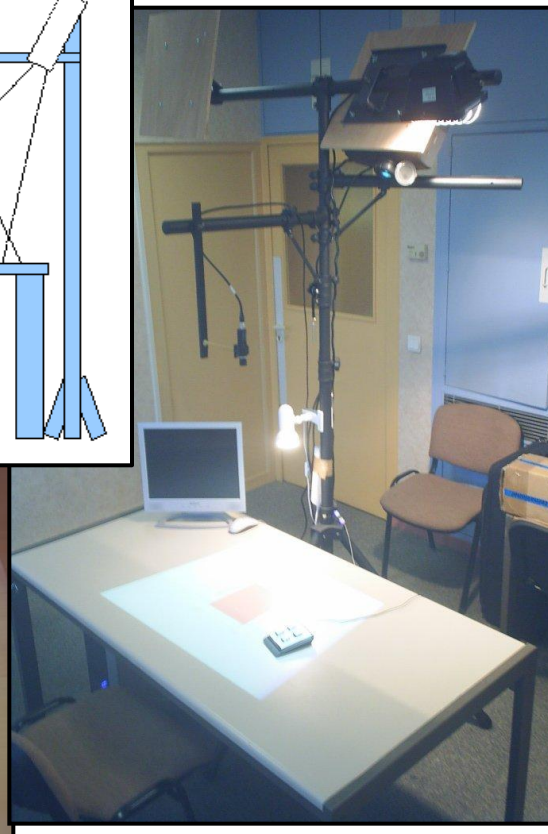
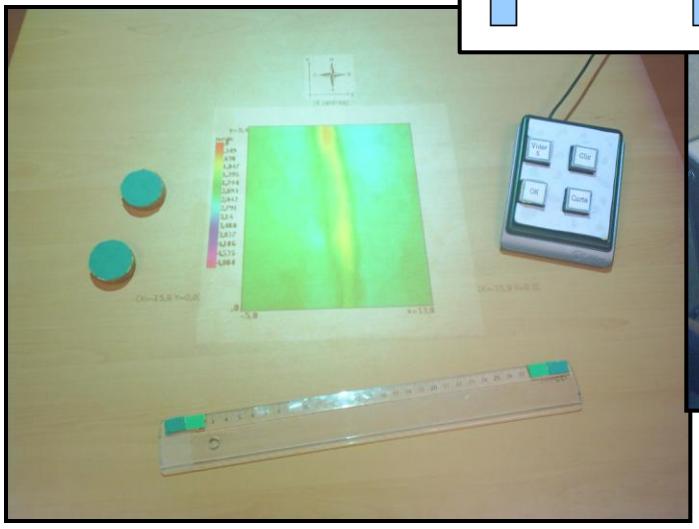
Physical setup

- Lighting tripod stand
- Common video-projector
- RGB video-camera
- USB keypad







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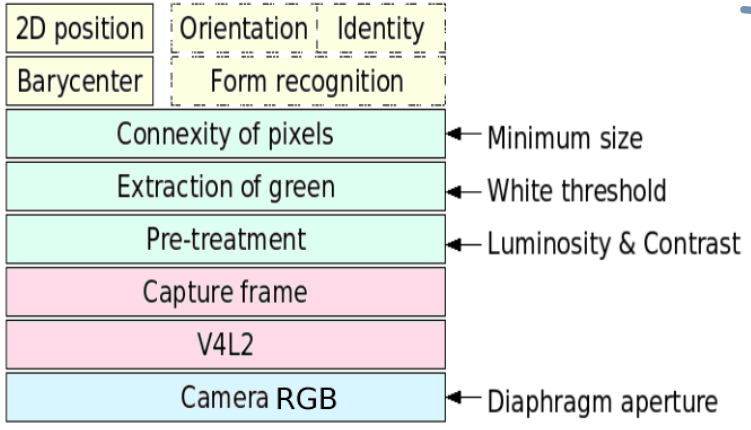
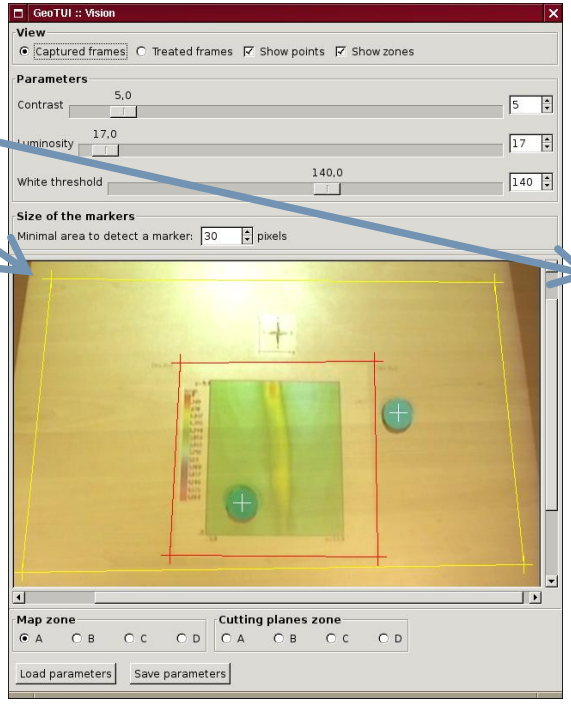
Computer vision

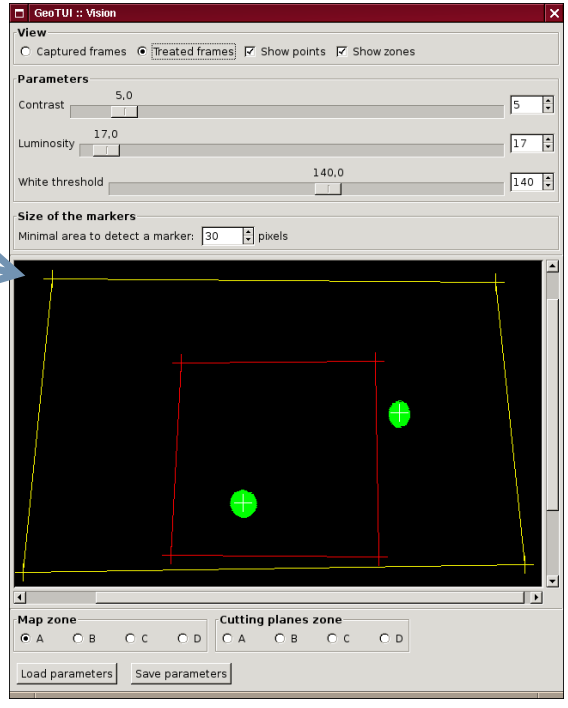
- Detection of the tangibles and the map

View of the video-camera





Raw capture



After treatment

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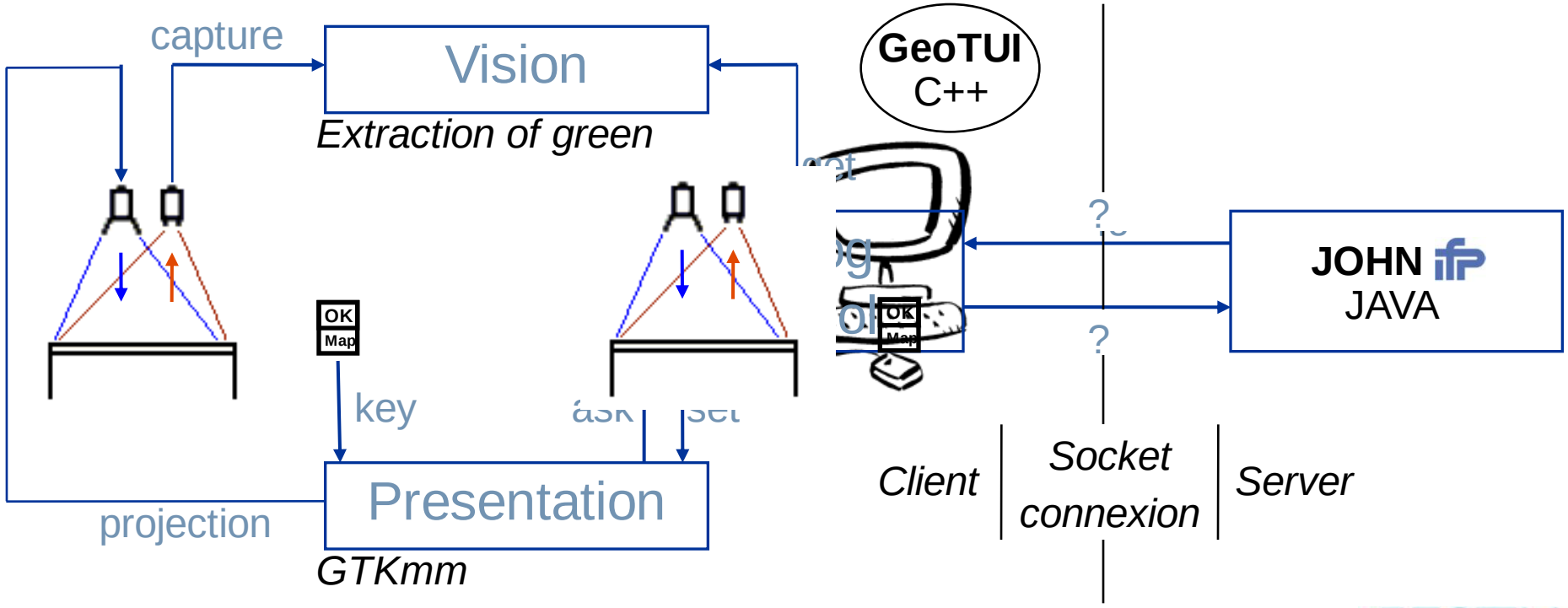
Software architecture

- The interface substitution



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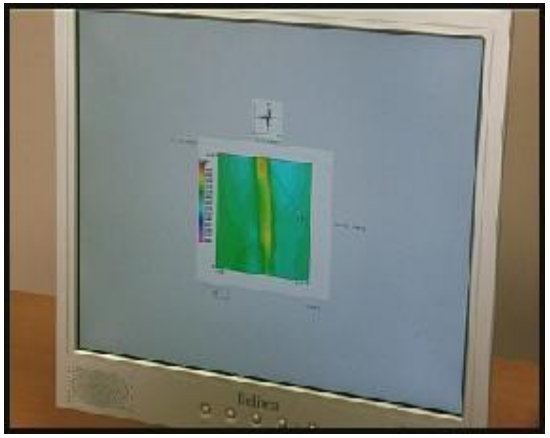
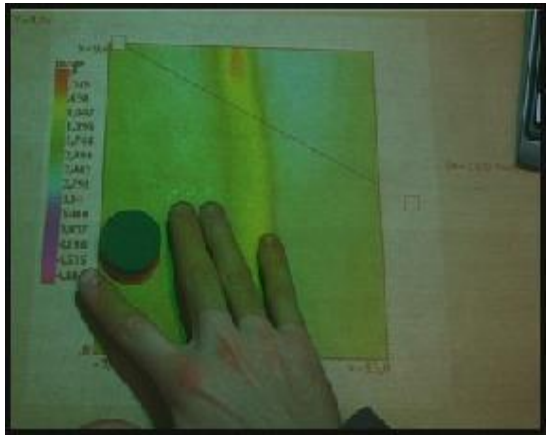
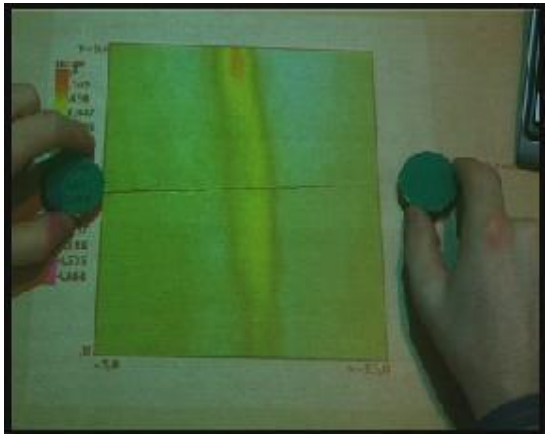
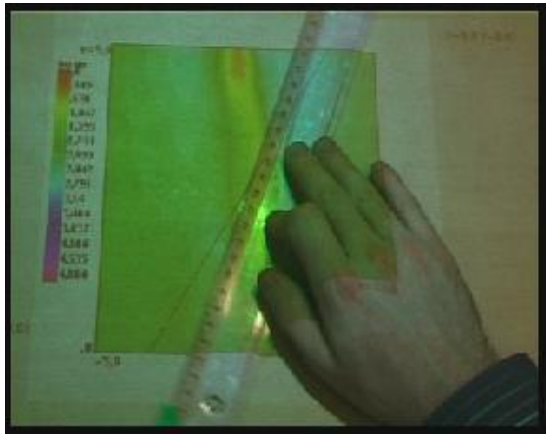
Experimentations









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Experimentations

- Two user studies
  - On-site in the workplace of the geophysicists
    - A dozen of persons from the IFP
    - Questionnaire for qualitative and subjective feedback
    - Important user actions recorded in a logfile
  - Within-subject design
    - GUI / TUI order counterbalanced
    - Props order counterbalanced

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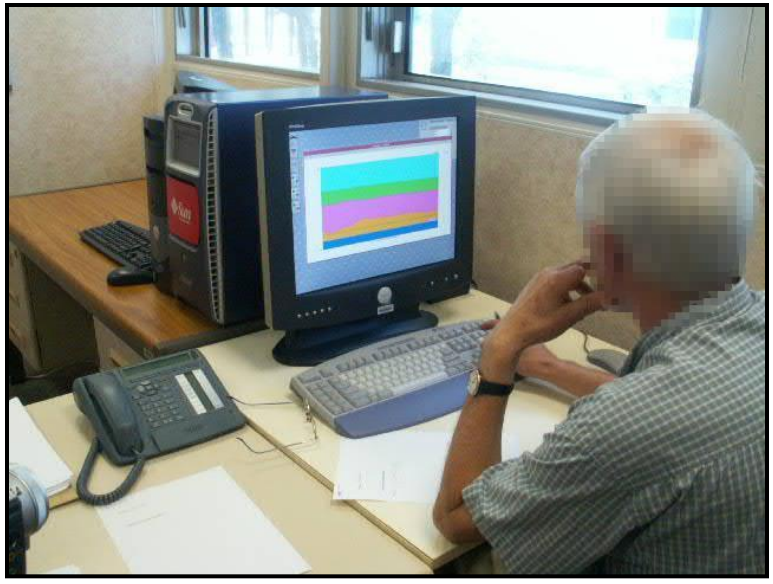
First user study

- Acceptance of such a new kind of interface?
- Which props is associated to the task?



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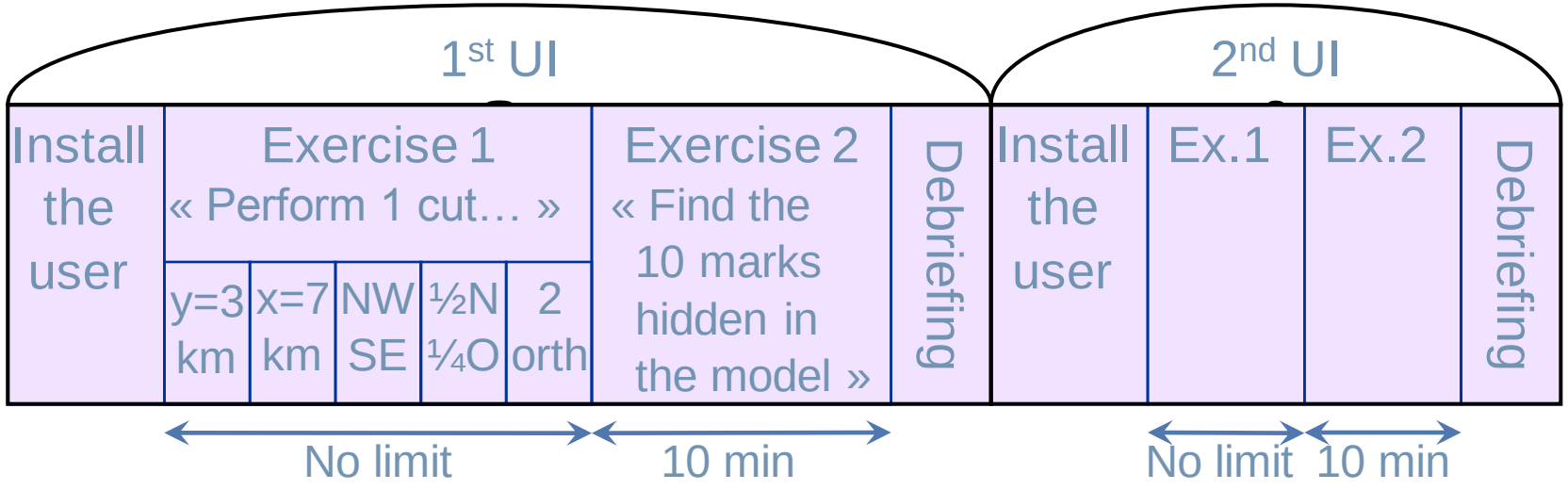
First user study

- Design of the study



	1st UI	2nd UI
S_1 = ½ {Subjects}	GUI	TUI
S_2 = {Subjects} \ S_1	TUI	GUI

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Results of first study

- Acceptance of the geophysicist
  - Nobody refused to use TUI
  - 2 subjects (20%) refused to use GUI
  - TUI had the advantage to be innovative

- 100% of the subjects took the ruler prop

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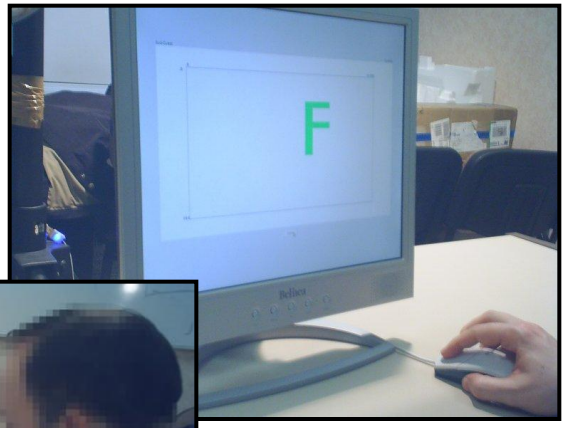
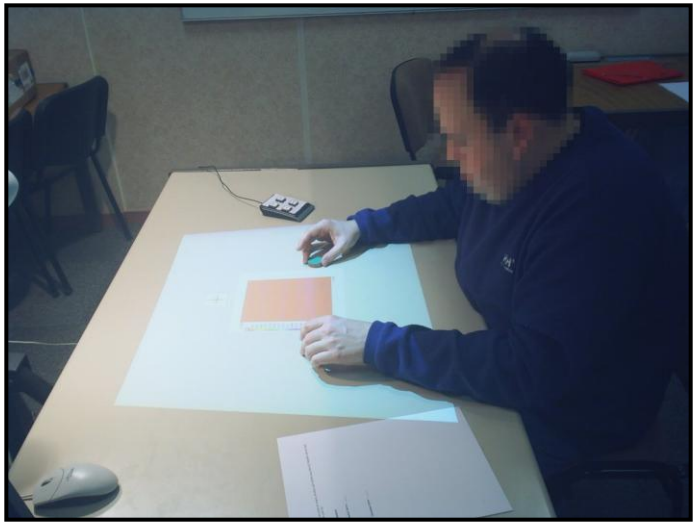
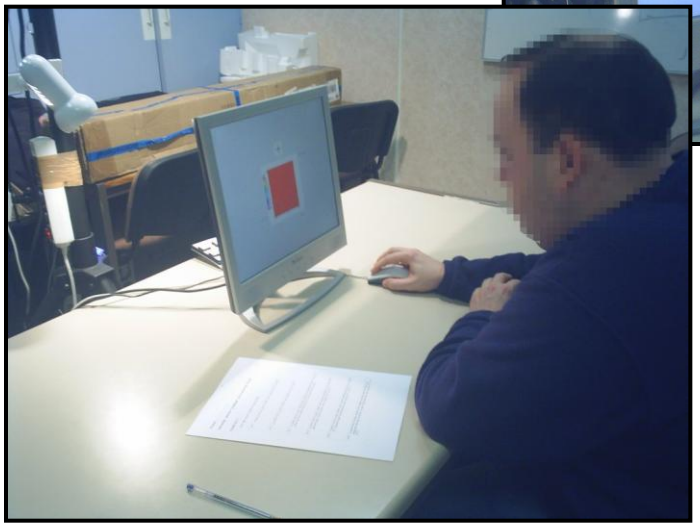
Second user study

- Evaluate and compare the four interactions
  - Manipulation time
  - Quality of the results







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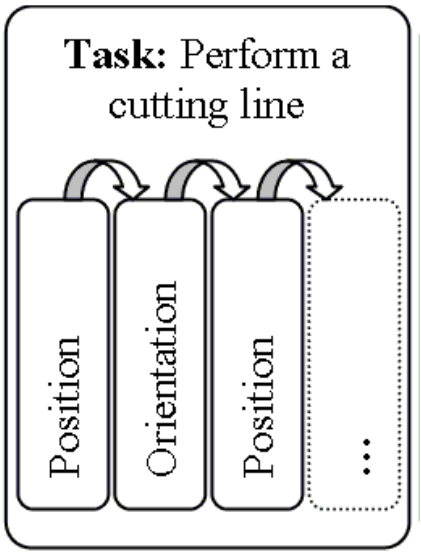
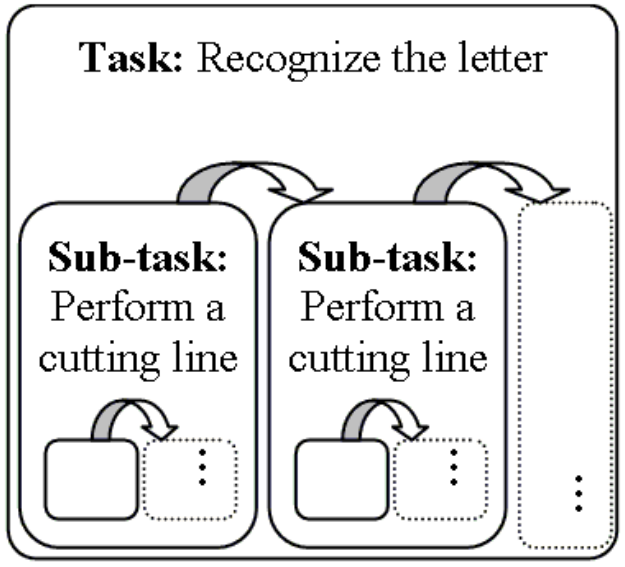
Second user study



Simple task



Composed task

Payne 1986

- Exercise1: **6 simple tasks**
- Exercise2: **1 composed task**

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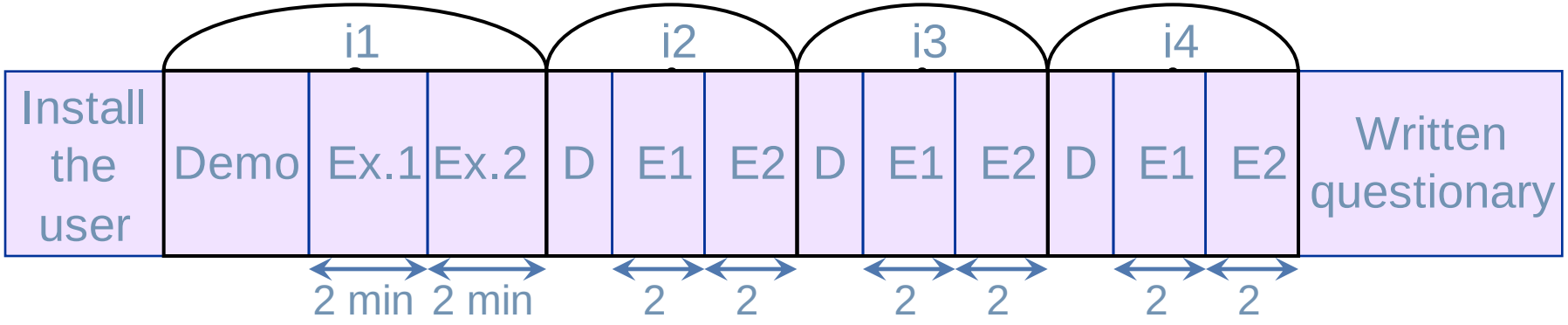
Second user study

- Design of the study



	i1	i2	i3	i4
Subject 1	*M*	*1P*	*2P*	*R*
Subject 3	*M*	*1P*	*R*	*2P*
Subject 5	*M*	*2P*	*1P*	*R*
Subject 7	*M*	*2P*	*R*	*1P*
Subject 9	*M*	*R*	*1P*	*2P*
Subject 11	*M*	*R*	*2P*	*1P*

	i1	i2	i3	i4
Subject 2	*1P*	*2P*	*R*	*M*
Subject 4	*1P*	*R*	*2P*	*M*
Subject 6	*2P*	*1P*	*R*	*M*
Subject 8	*2P*	*R*	*1P*	*M*
Subject 10	*R*	*1P*	*2P*	*M*
Subject 12	*R*	*2P*	*1P*	*M*

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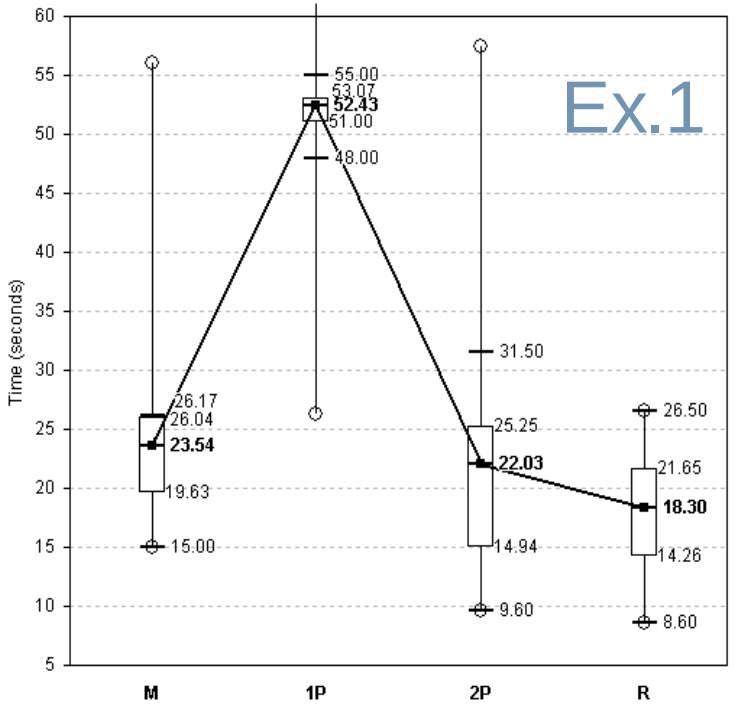
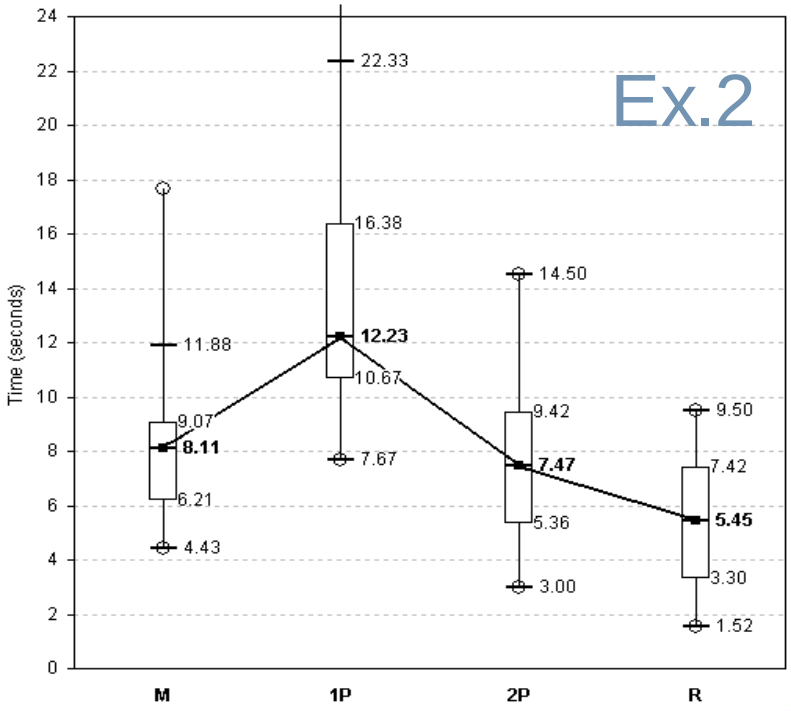
Results of second user study

- Number of letters well-recognized
- Mean times to select a cutting line





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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

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Definitions

- Characterization of input devices
  - Generic form / Specialized form

Fitzmaurice, Buxton, 96, 97

« specialized form when it roughly matches the shape and manipulation characteristics of the logical controller »

- Cutting line selection task

		Multiplex	Form
GUI	Mouse	*Time*	*Generic*
TUI	1-Puck	*Time*	*Generic*
	2-Puck	*Space*	*Generic*
	Ruler	*Space*	*Specialized*

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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 **Fitzmaurice 96 Chap 6.1**	✓	✗	Spec. ~ Gen.
Ex1: Perform a series of six cutting planes	✓	✗	*R ~ 2P* 5% speedup
Ex2: Recognize a letter	✓	✓	*R > 2P* 18% speedup 133% performance gain


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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

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Conclusion

- Tangible UI on a tabletop for geoscience
- Mobile hardware setup for TUI on a Tabletop
- Two user experiences
  - Adhesion of the geophysicists
  - The choice of the ruler is justified for the cutting line selection task
- Specialized devices perform better than generic ones for composed tasks

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Thank you for your attention.

A video is available on **http://www.estia.fr/~geotui**