

# **CubeExplorer: An Evaluation of Interaction Techniques in Architectural Education**

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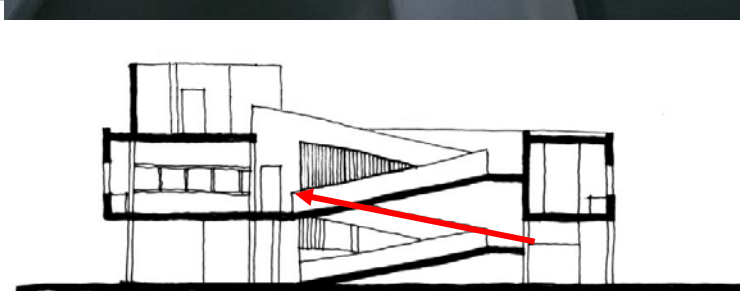
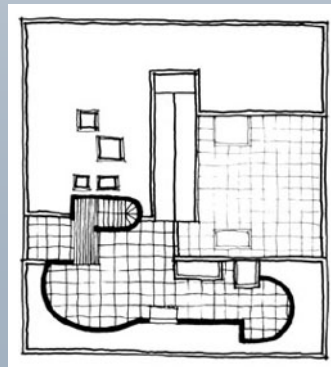
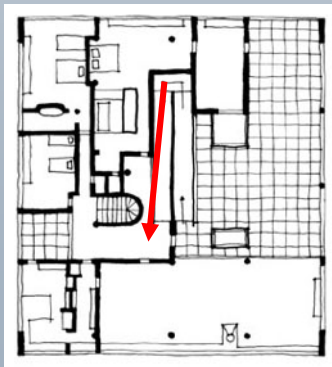
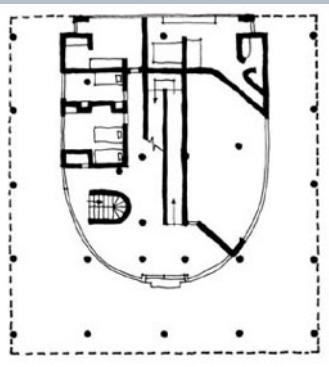
# In architecture Education

- Teach the concept of different figural voids
  - empty spaces, subtraction of spaces

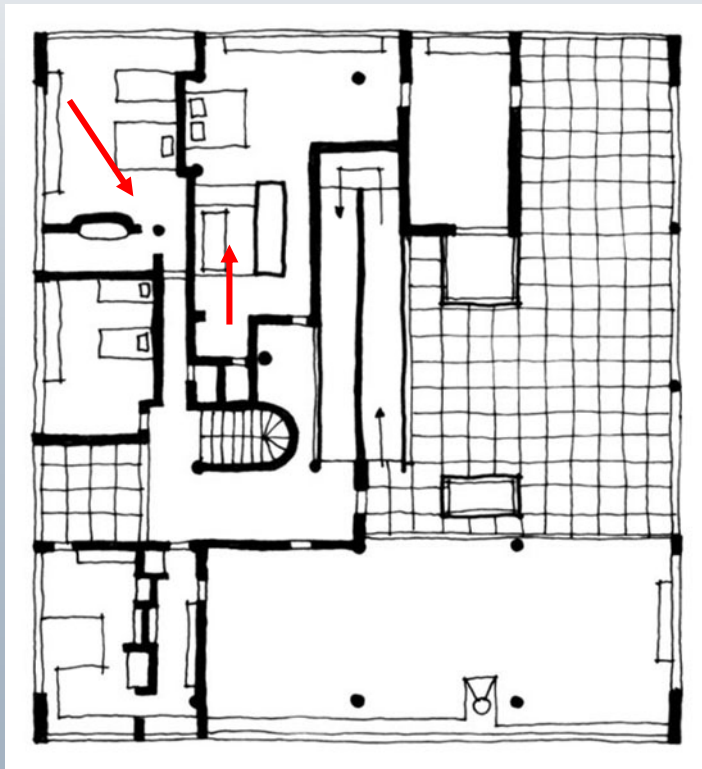


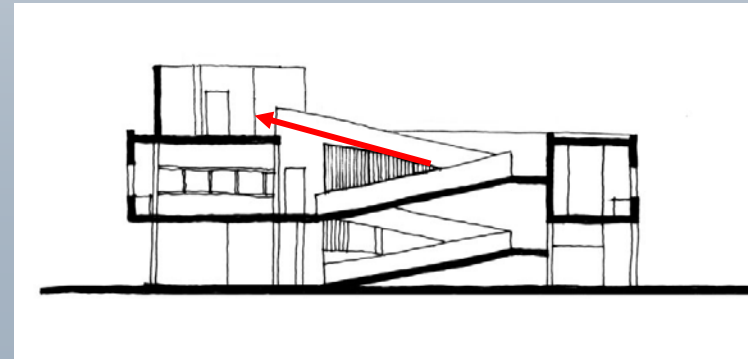
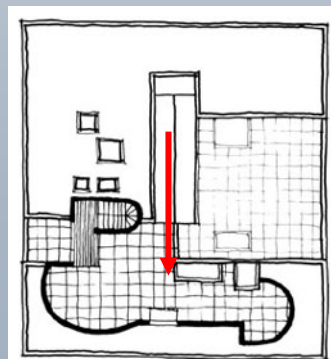
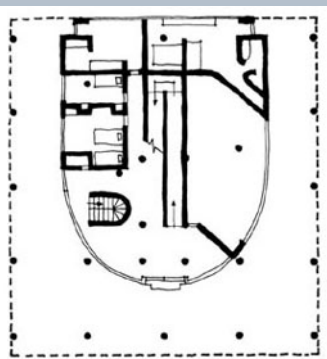
**Villa Savoye** Poissy-sur-Seine , France, LeCorbusier 1928-1931

# Example of spaces





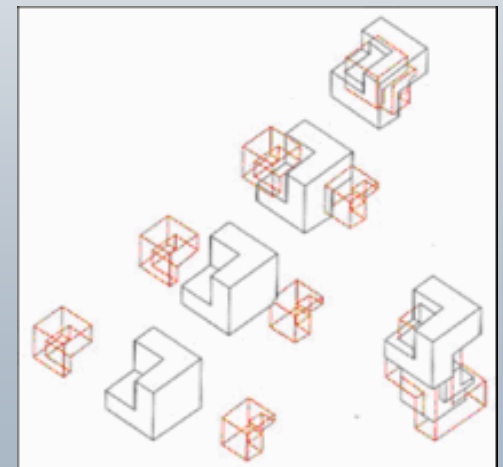
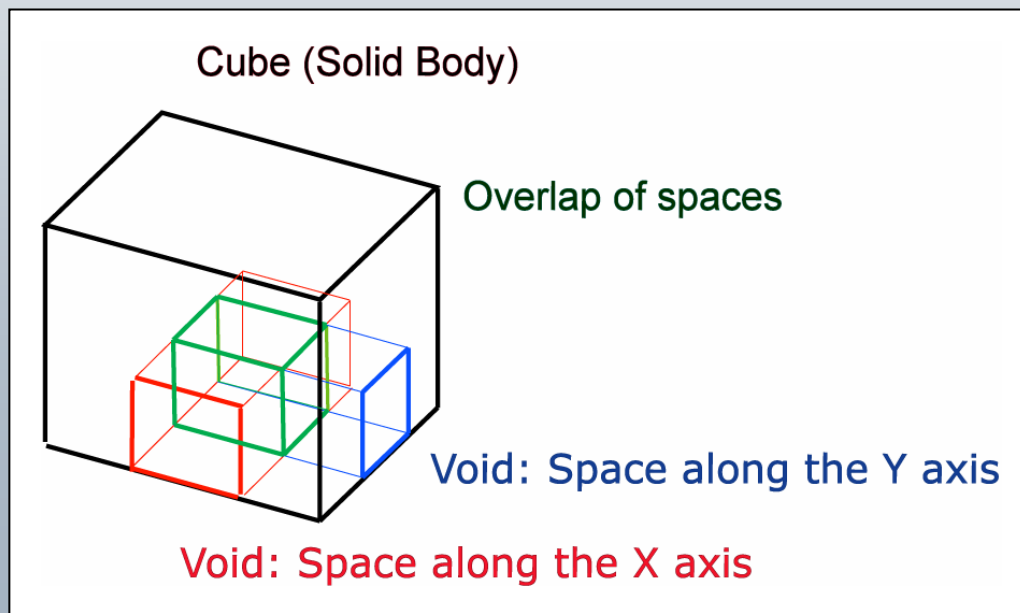






# The Cube Project

- Introductory Architecture Curriculum
  - Explore different empty spaces (negative figural void)
- Task
  - Subtract part of a solid cube using different tools
  - Create empty that overlap
  - Demonstrate a strategy of spatial organization



**<Peter Eisenman>**  
**"Cube in a Cube" House 11a**

# Different Types of Tools

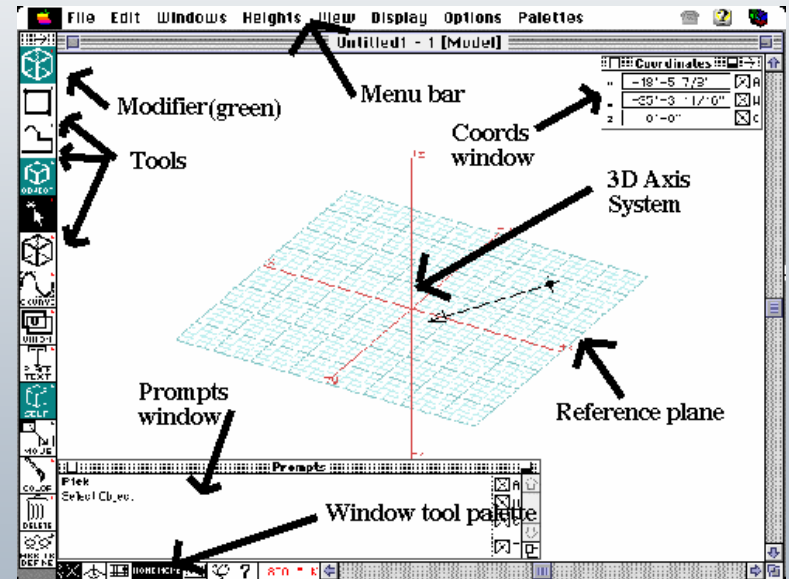
## □ Physical Tool

- Wooden Block



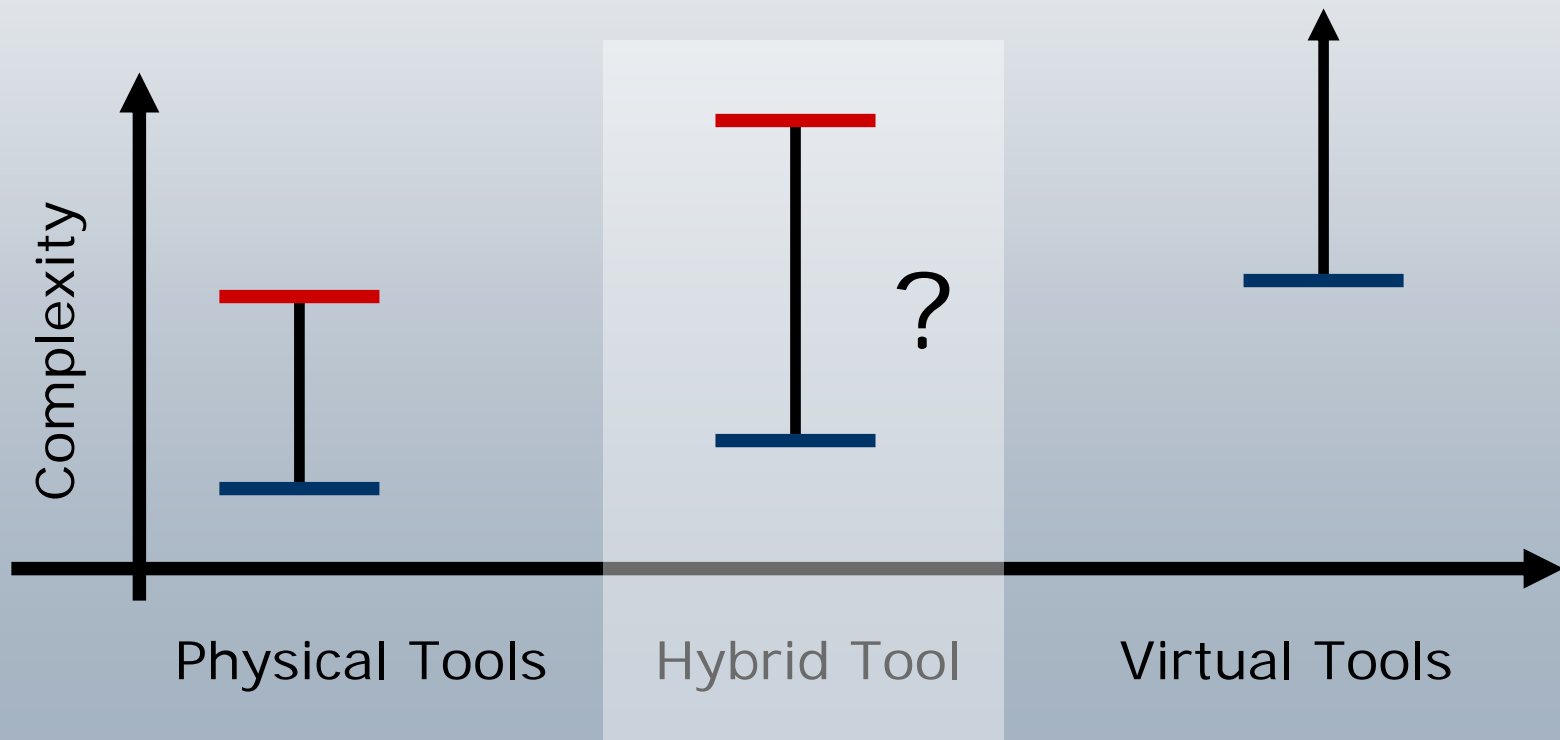
## □ Virtual Tool

- 3D cad program
- FormZ



# Better Tool?

- Threshold ———
  - How difficult it is to learn how to use the system
- Ceiling ———
  - How much can be done using the system



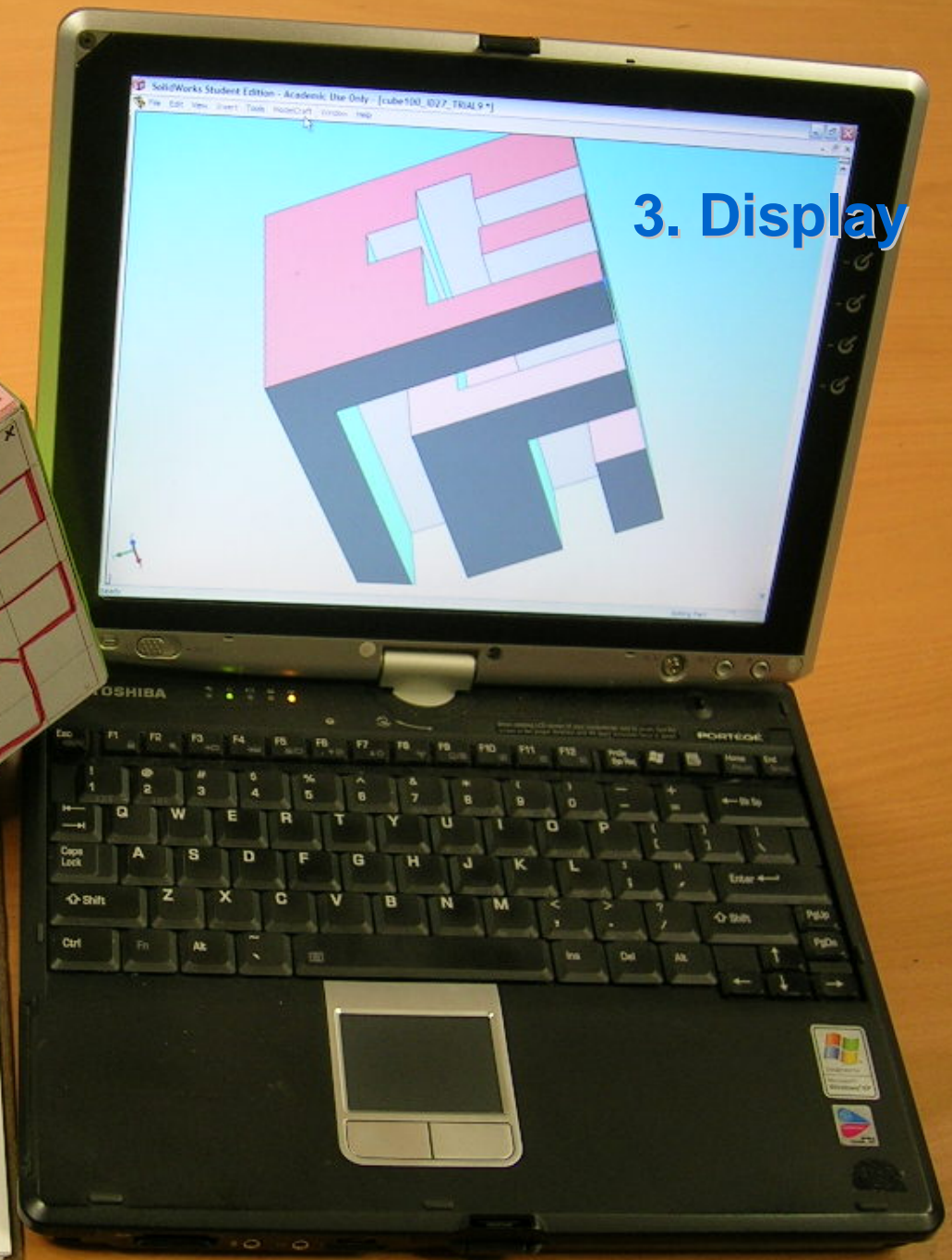
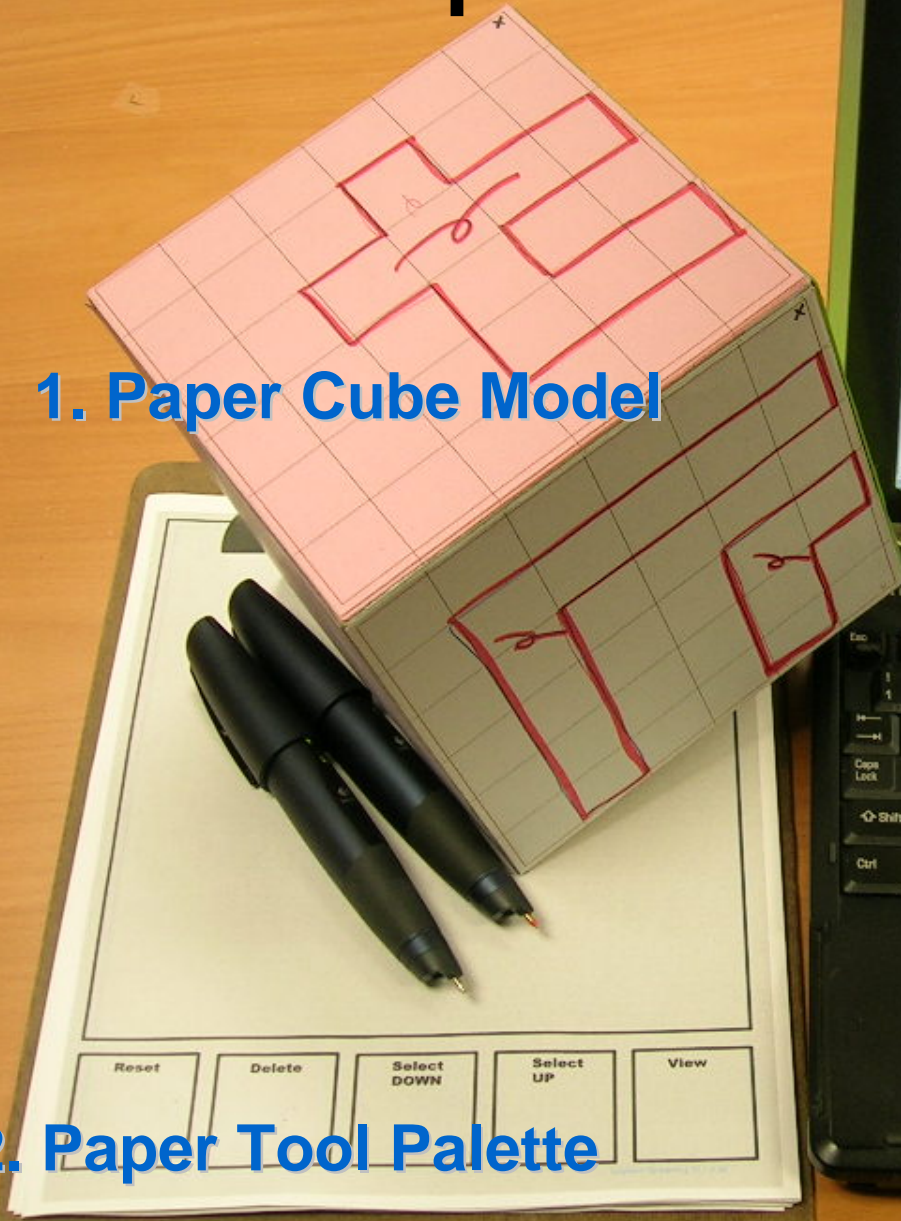


# CubeExplorer

1. Paper Cube Model

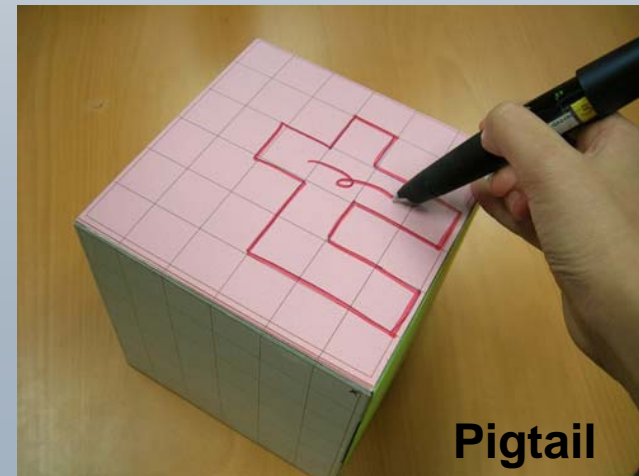
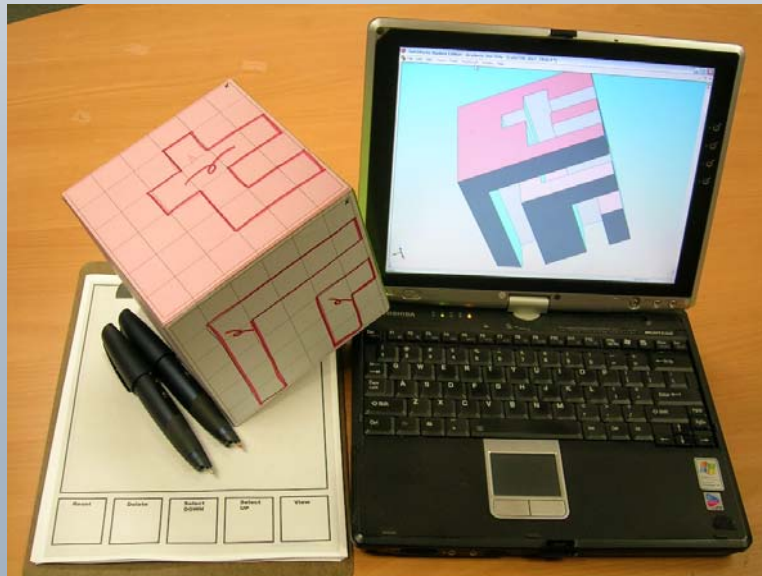
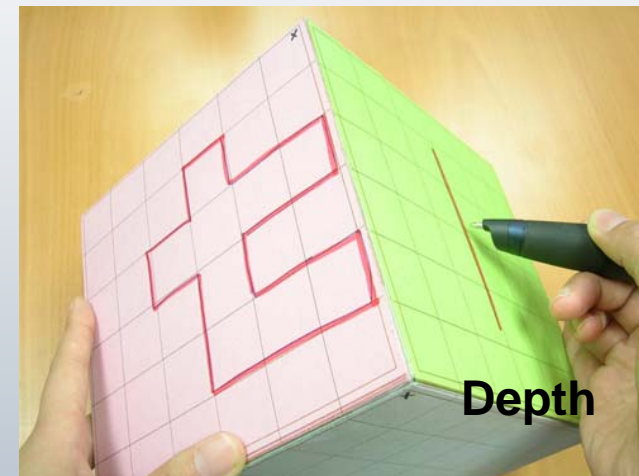
3. Display

2. Paper Tool Palette



# Design Objectives

- Easy to operate
  - Write on the facing surface
  - Direct formal and spatial manipulation
- Easy to learn
  - Sketching with pen is a common practice for designers
  - Simple syntax



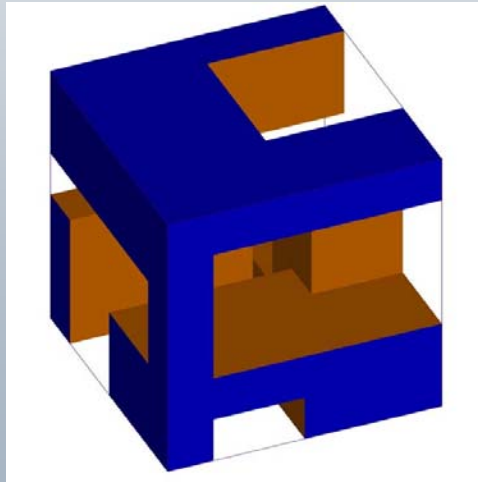


# Experiment 1

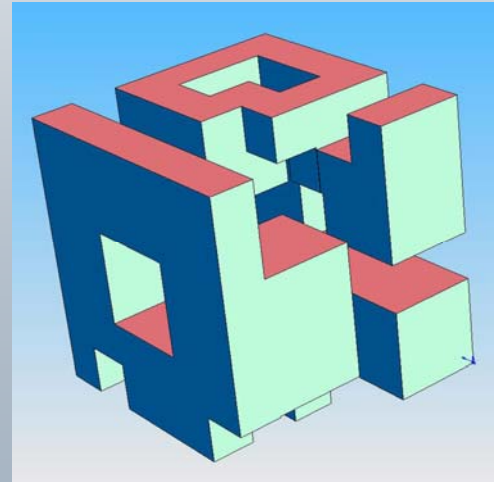
- Demonstrate spatial organization
- Protocol
  - ARCH400 class students at our university
  - 3 **groups (tools)** of 3 participants : total of 9 students
  - Post questionnaire by participants  
+ evaluation of the 27 models by two faculty



Wooden Blocks  
**Physical Tool**

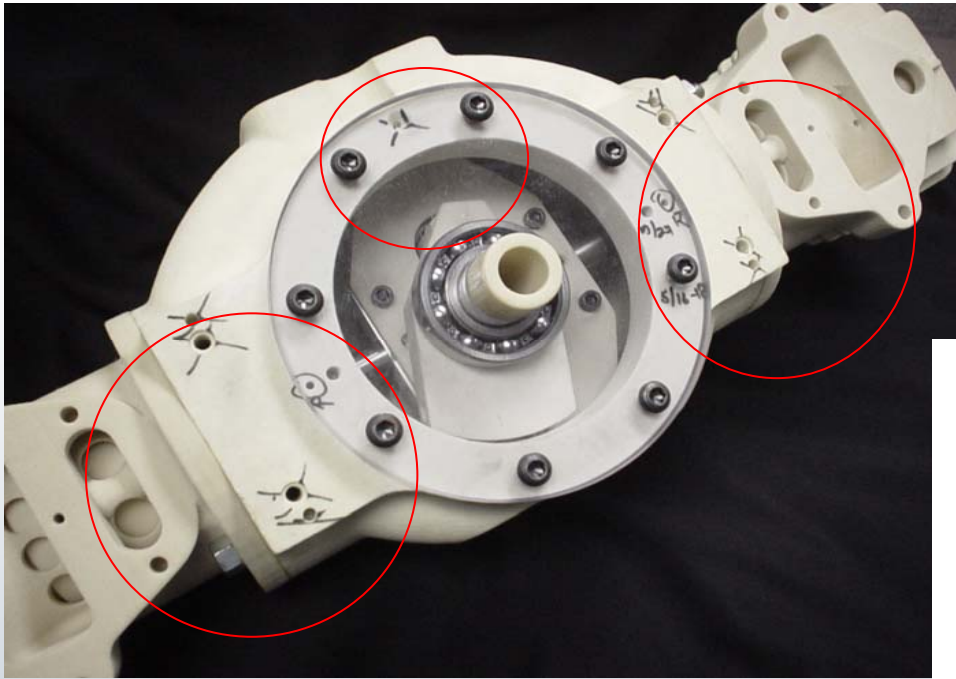


Digital Modeler (FormZ)  
**Virtual Tool**

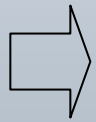


CubeExplorer  
**Hybrid Tool**

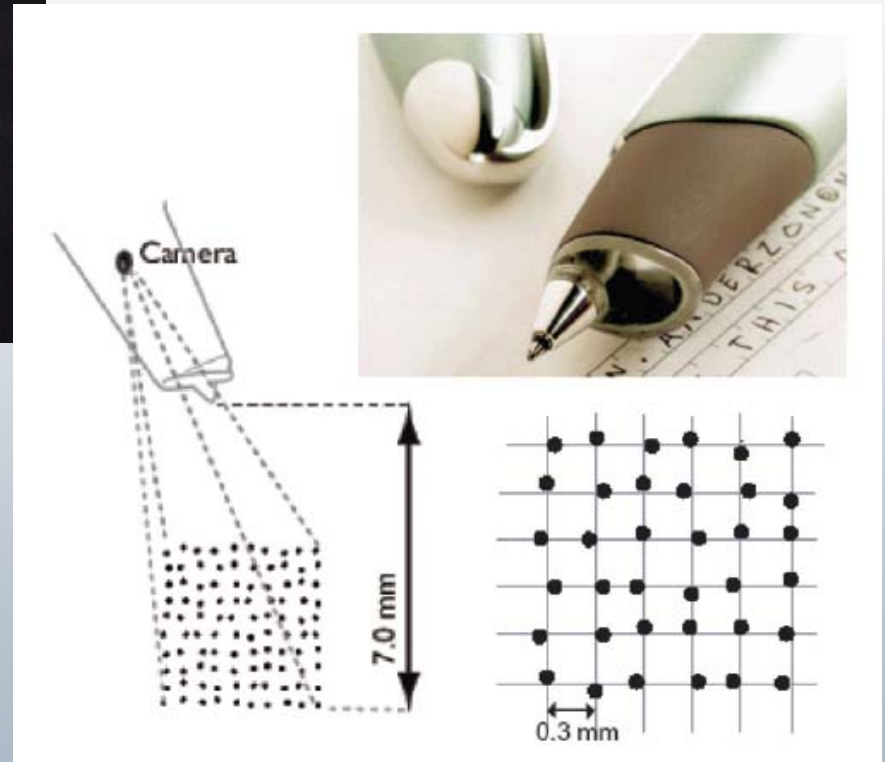




Provided by ZCorp



## **Anoto Pattern Digital Pen Technology**



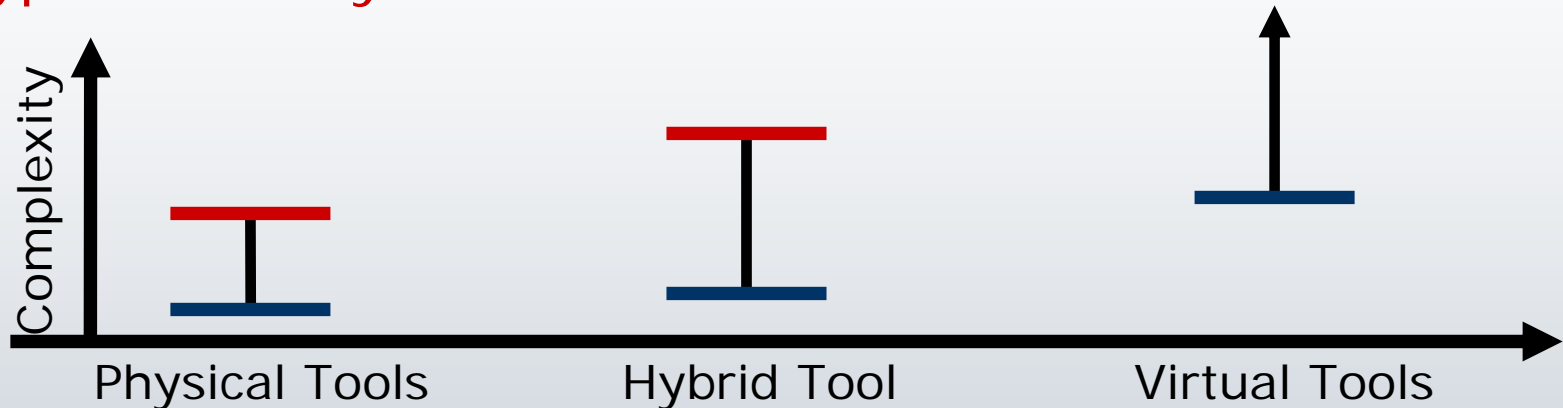
Anoto 02, Development Guide for  
Service Enabled by Anoto  
Functionality.

# Hypothesis

- CubeExplorer brings unique opportunity for architecture practice and education
- Q1: Synthesis of both media?
  - Physical Interface
    - Ease of navigation, ease of parameter specification
  - Virtual Interface
    - Relaxed physical constraints
    - Undo and save operations
- Q2: Facilitate the spatial cognition process?
  - Relationship between 2D and 3D mapping
  - Orthogonal Projection

# Findings

Hypothesis: Synthesis of both media?

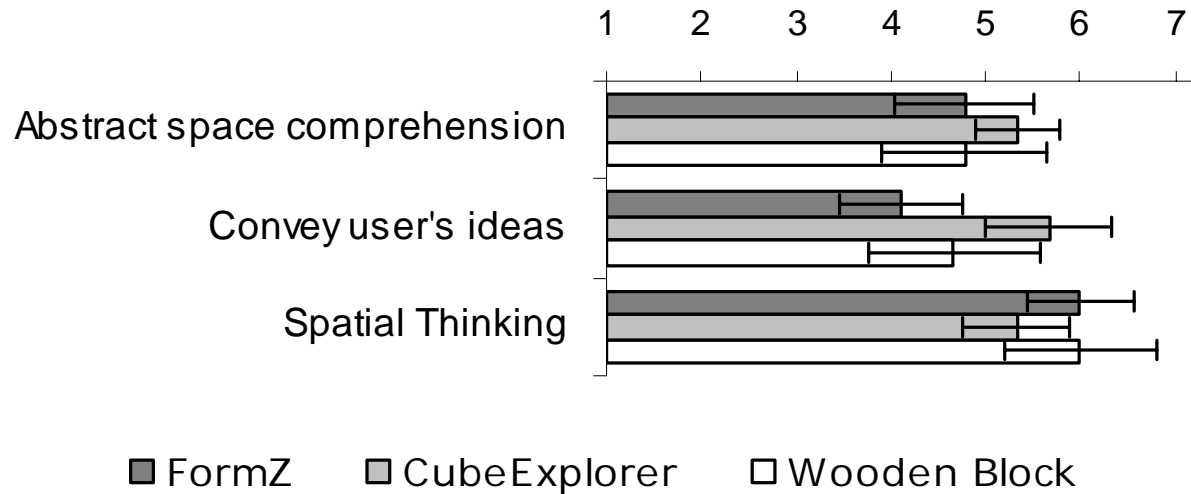


- CubeExplorer had low *threshold*
  - Easy to start, Less time spent to learn
  - sketch based interface allows the user to think in incremental dimension. Ex. point, shape, object
- Operation available in virtual tools are readily available in hybrid tools
  - Efficient to subtract a section
  - Easy to correct errors and make changes



# Findings

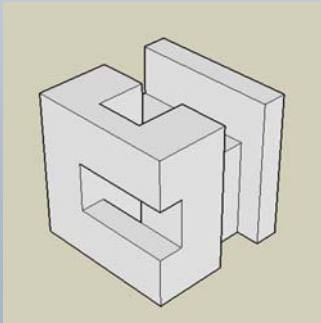
Hypothesis: Facilitate the spatial cognition process?



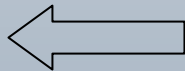
- ❑ Coherent with independent ratings of the result models from two architect professor
- ❑ Each tool aids developing different aspect of architectural space concept

# Experiment 2

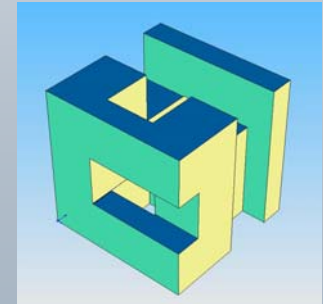
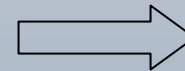
- Target Matching Task
  - To gain external validity
- One-way repeated measures ANOVA
  - Indep. Var : **SketchUp vs.CubeExplorer**
  - Dep. Var: Task Completion Time
    - **p = .015 (CubeExplorer significantly faster)**
- Why faster?
  - Context Awareness



Digital Modeler  
(SketchUp)  
**Virtual Tool**



Target Model  
**Wooden Blocks**



CubeExplorer  
**Hybrid Tool**

# Discussion

- ❑ Disadvantage of Tangible User Interface
  - Synchronization
    - ❑ Inconsistency btw sketch on the screen and on the model (ex. Undo operation)
  - Alignment
    - ❑ Paper model cube vs. Cube on the screen
- ❑ To achieve external validity
  - Compare with other TUI interface
  - Simple Task vs General Task
  - Novice user group vs. General user group

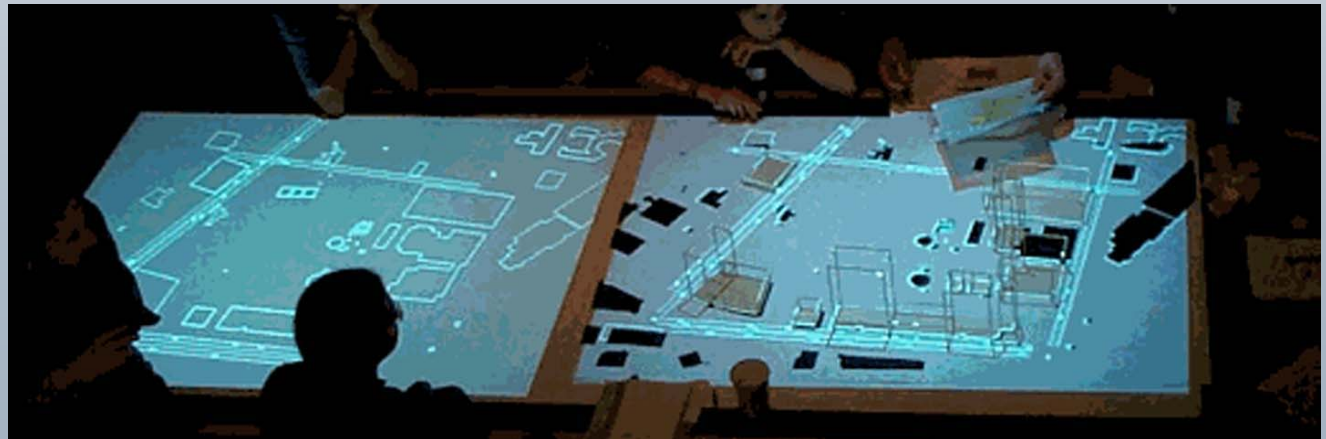


# Future Work

- Comparison with other TUIs
  - Watanabe ACE04' ActiveCube



- Extend to Larger scale design practice
  - URP, Underkoffler CHI'99



# Conclusion

- Benefits of hybrid tangible user interface
  - Combines the advantage of physical and digital media
    - Less mental load to learn
    - Supports complex operations
  - Direct Manipulation
    - Operation order are in accordance with how students conceptualize 3D object
    - Navigation is easier
    - Fewer parameters to specify
- Challenges in hybrid tangible user interface
  - Synchronization and alignment between physical proxy and virtual representation

# Thank you

## Questions?

## Acknowledgements

- Microsoft Research & NSF Grant IIS-0447703
- ARCH100 & ARCH400 students
- Special Thanks
  - Adam Bender, Corinna Lockenhoff

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