Alternative Tools for Tangible Interaction: A Usability Evaluation

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Outline

- Motivation: usability of TUIs
- Task design
- Cognitive support; tool design
- Experimental hypotheses and design
- Experimental results
- Conclusion
- Future work

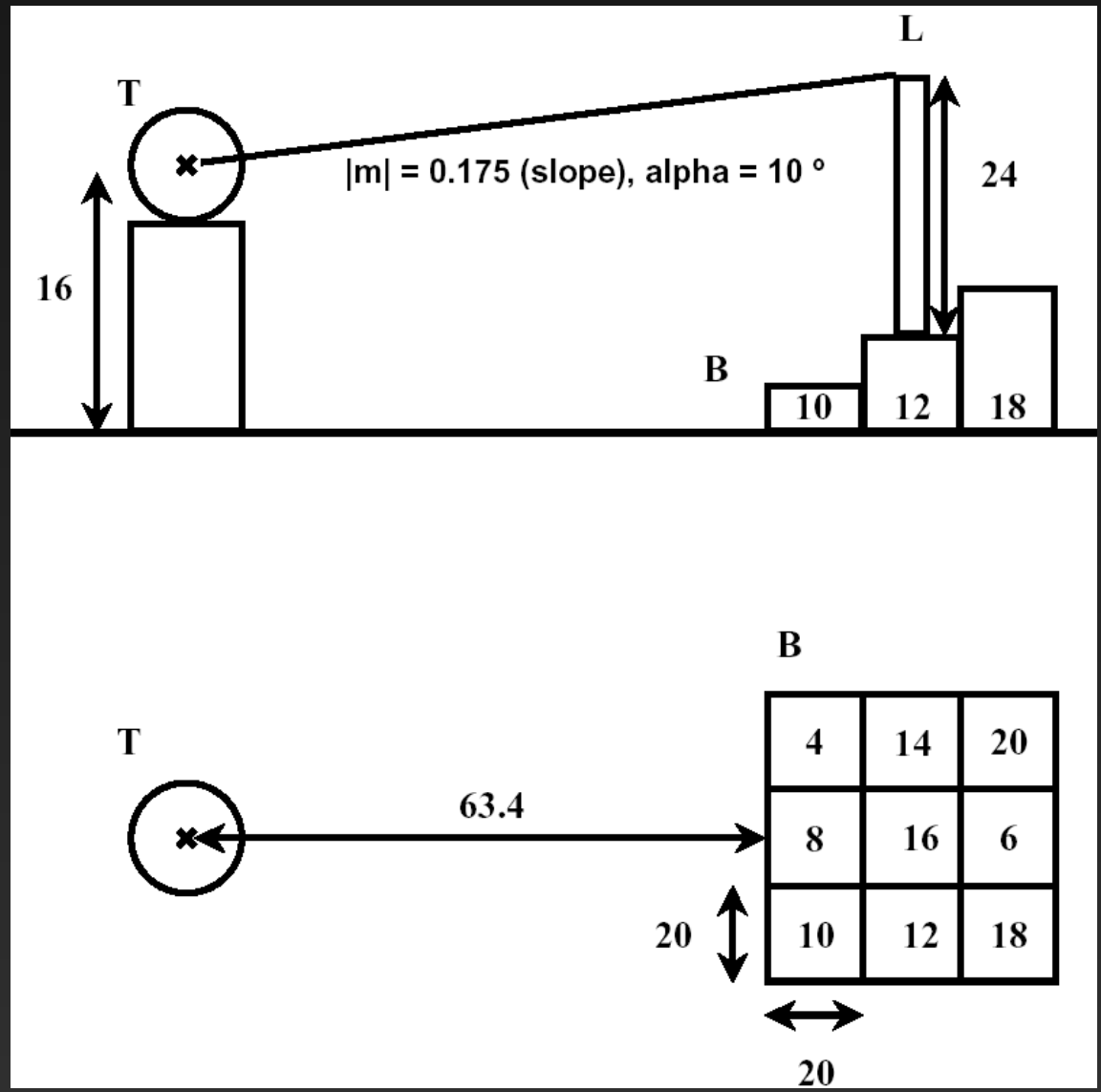
Motivation: usability of TUIs

Tangible User Interface vs. alternative tools

Video
CHI 2000

Task design

Positioning task that needs cognition & interaction



Cognitive support

We wanted to examine the cognitive support offered by the TUI

Hence, we sought alternative tools
- a) for the same task
- b) giving different cognitive support
- c) reflecting different real world aspects

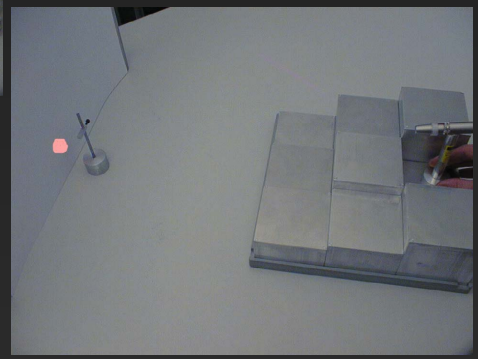
The TUI and the alternative tools would then be evaluated in terms of their cognitive support

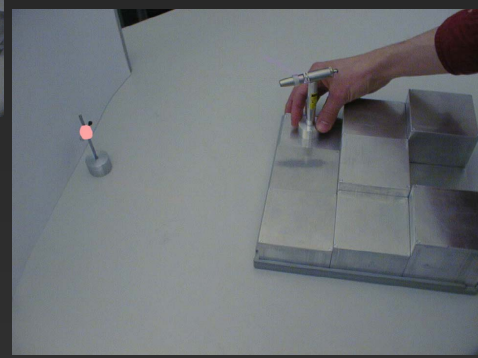
Tool design

A set of decision support techniques guided the design of alternative tools (Zachary, 1986).

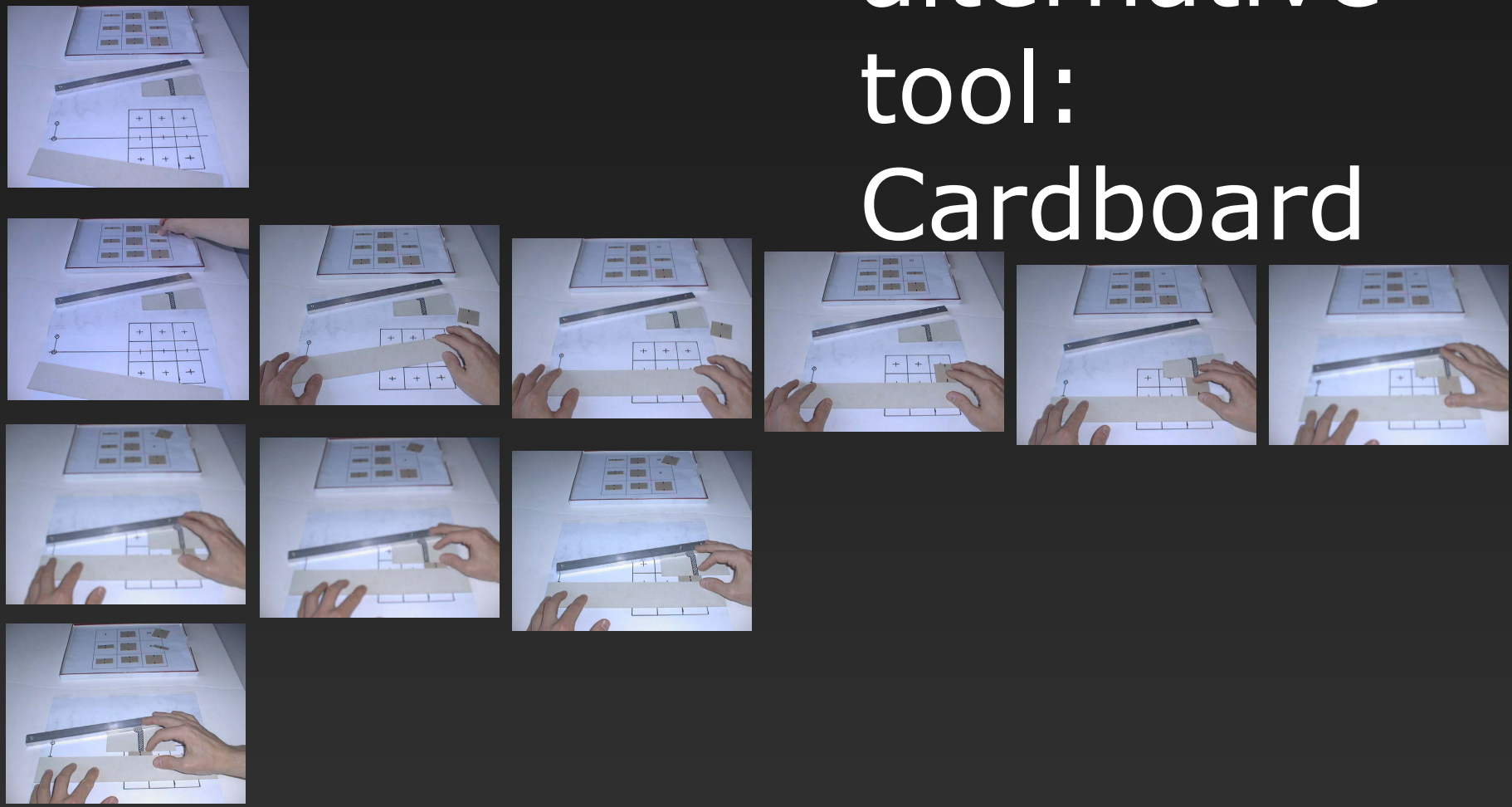
- Focus on problem representation
- Design tools that can be easily learned
- Design tools for different strategies
- Design tools facilitating rational decision-making

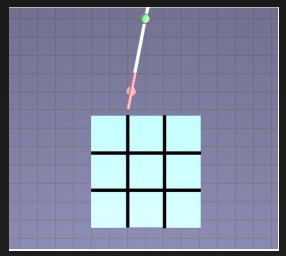
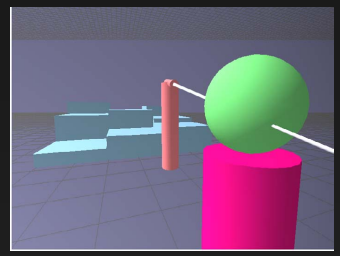
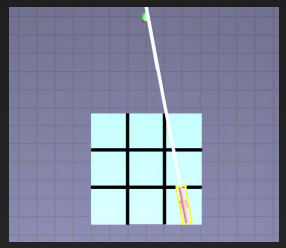
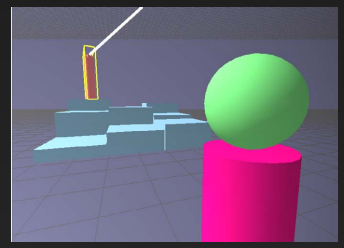
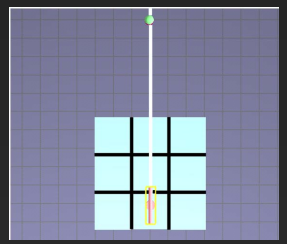
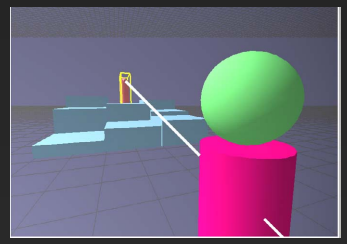
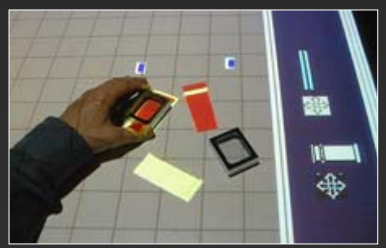
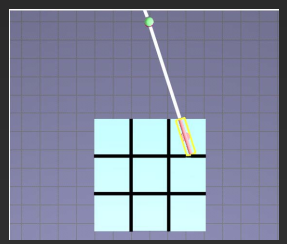
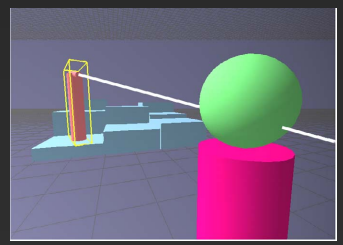
„Supportive" alternative tool: Physical





„Demanding“ alternative tool: Cardboard



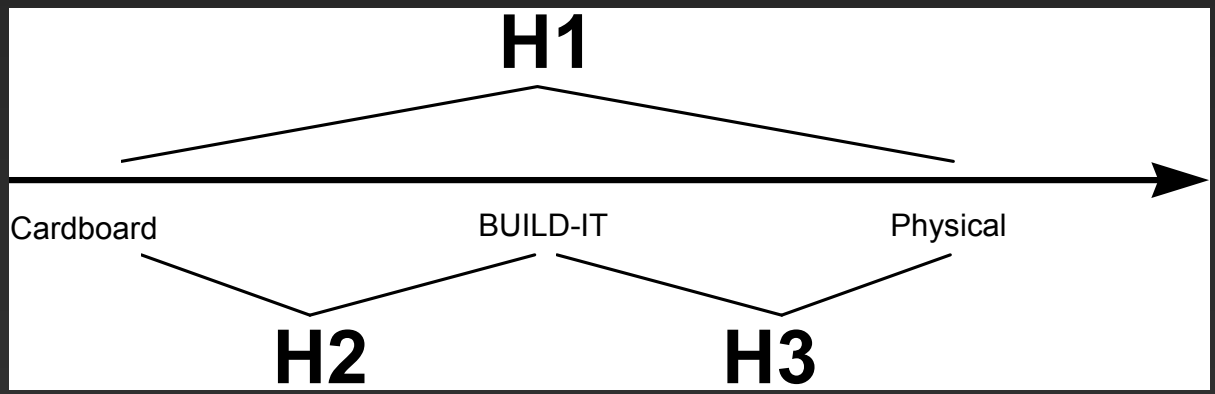
TUI/BUILD-IT

Hypotheses

H1: Cardboard gives less cognitive support than PhysicalBlocks.

H2: Cardboard gives less cognitive support than BUILD-IT.

H3: BUILD-IT gives less cognitive support than PhysicalBlocks.



Operationalization of cognitive support

C1: Lower trial time

C2: More blocks tested per trial (epistemic action reduces cognitive load, Kirsh & Maglio, 1994)

C3: Learning effect in trial time (first vs. last)

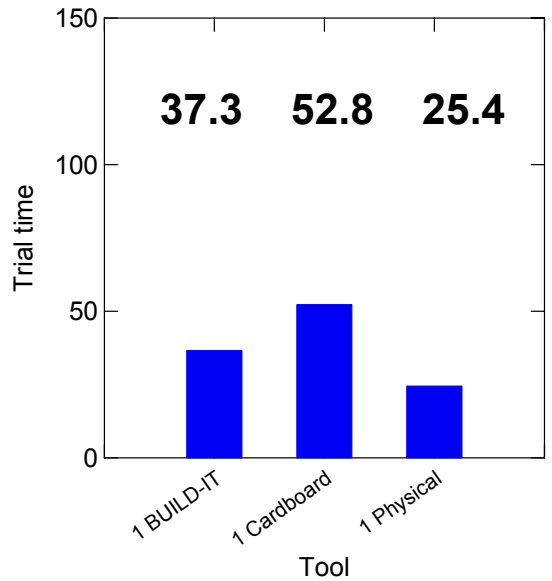
C4: Learning effect in blocks tested (first vs. last)

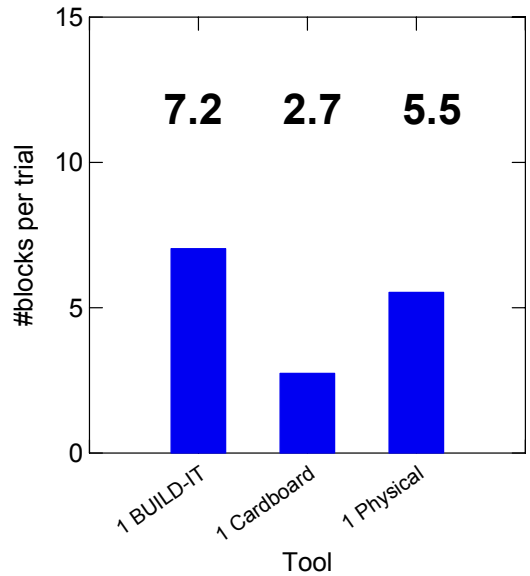
C5: Higher user satisfaction with task-tool combination used (perceived clarity of task formulation, task difficulty, and tool suitability)

Experimental design

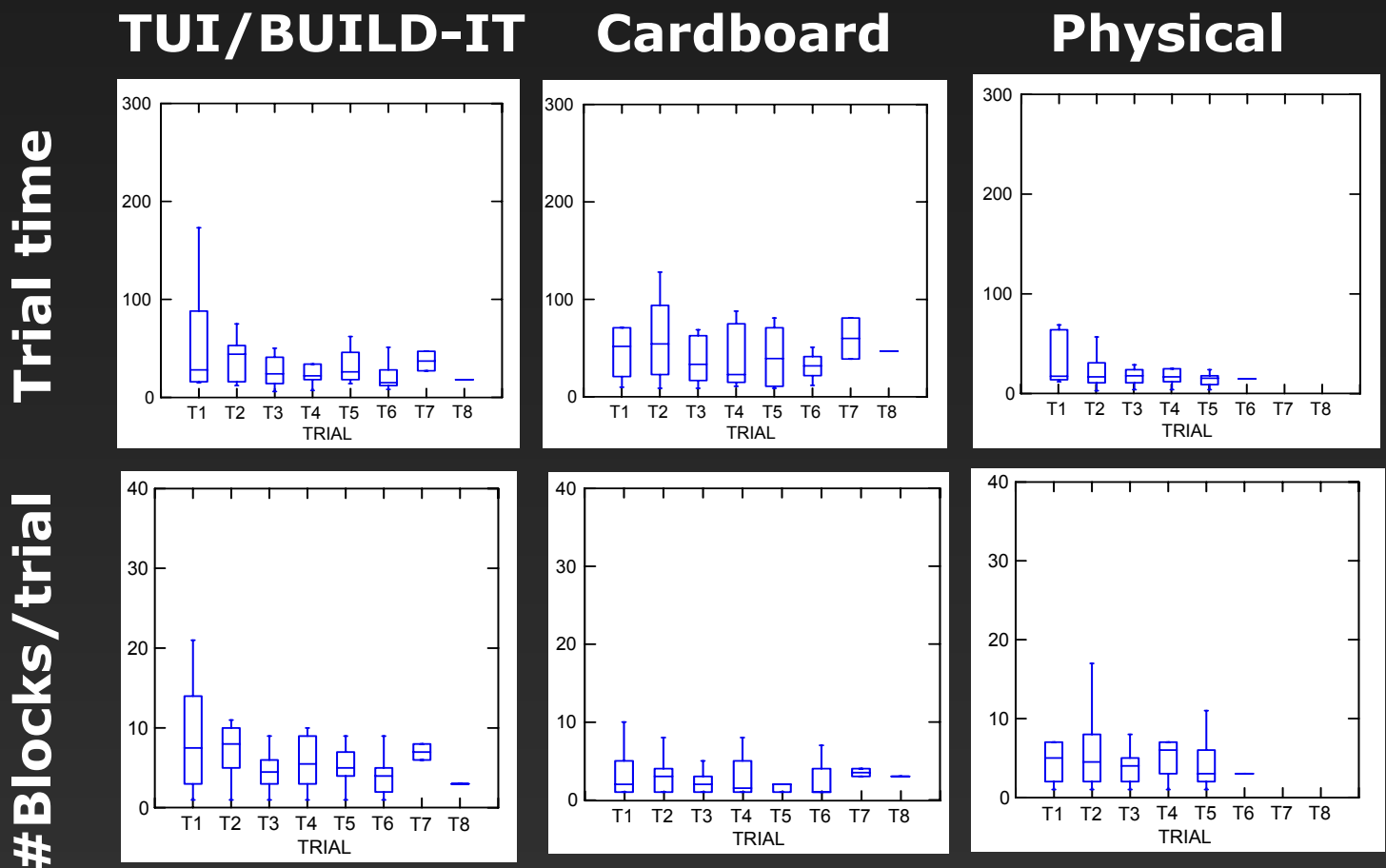
- Between-subject scheme, eliminating between-tool learing
- Ten participants for each tool, altogether thirty
- 12 task variations, two for aided use, ten for "counting" unaided use
- Counting unaided task were were permuted
- Stop criterium: Five correct tasks, last three ones in a closed sequence

Results C1 and C2: trial time [s], # blocks (partly significant)





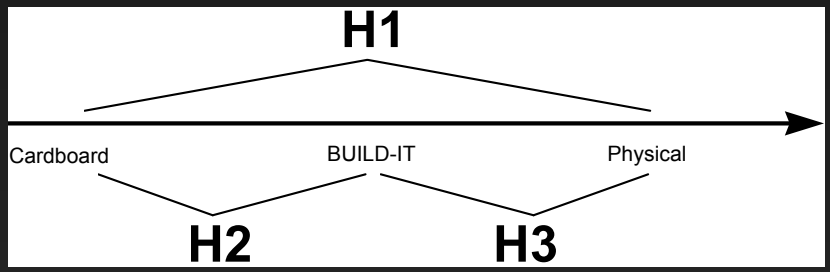
Results C3 and C4: Learning effects (not significant)



Results C5: Subjective preferences

	clarity	difficulty	suitability	total
TUI/BUILD-IT	1.4	0.5	0.9	0.9
Cardboard	1.3	0.3	1.4	1.0
Physical	1.7	1.2	1.1	1.3

Significant results (Yes/No)



	C1	C2	C3	C4	C5	$\Sigma C_{i,\ i=1-5}$
H1	**Yes**	**Yes**	No	No	**Yes**	**3**
H2	**Yes**	**Yes**	No	No	No	**2**
H3	No	No	No	No	**Yes**	**1**

Conclusions - TUI

- TUI is efficient -
  coming close to the physical tool

- TUI supports exploratory action -
  also coming close to the physical tool

- However, TUI needs to be more user friendly;
  - accuracy in rotation not satisfactory
  - scarce need for side view in problem solving
  - coordination plan side view demans learning

Conclusions - alternative tools

- Cardboard:
  Training helped, spurred reflection
  Different strategies were observed.

- Physical:
  Task tool separation unclear

Future work

TUI research needs further real-world anchoring to offer convincings solutions to architects, city-planners, and designers. Hence, either focus on

- task design: Explore other kinds of positioning, search, or path-pursuit tasks (Balakrishnan and Kurtenback, 1999), or

- tool design: Introduce CAD alternative

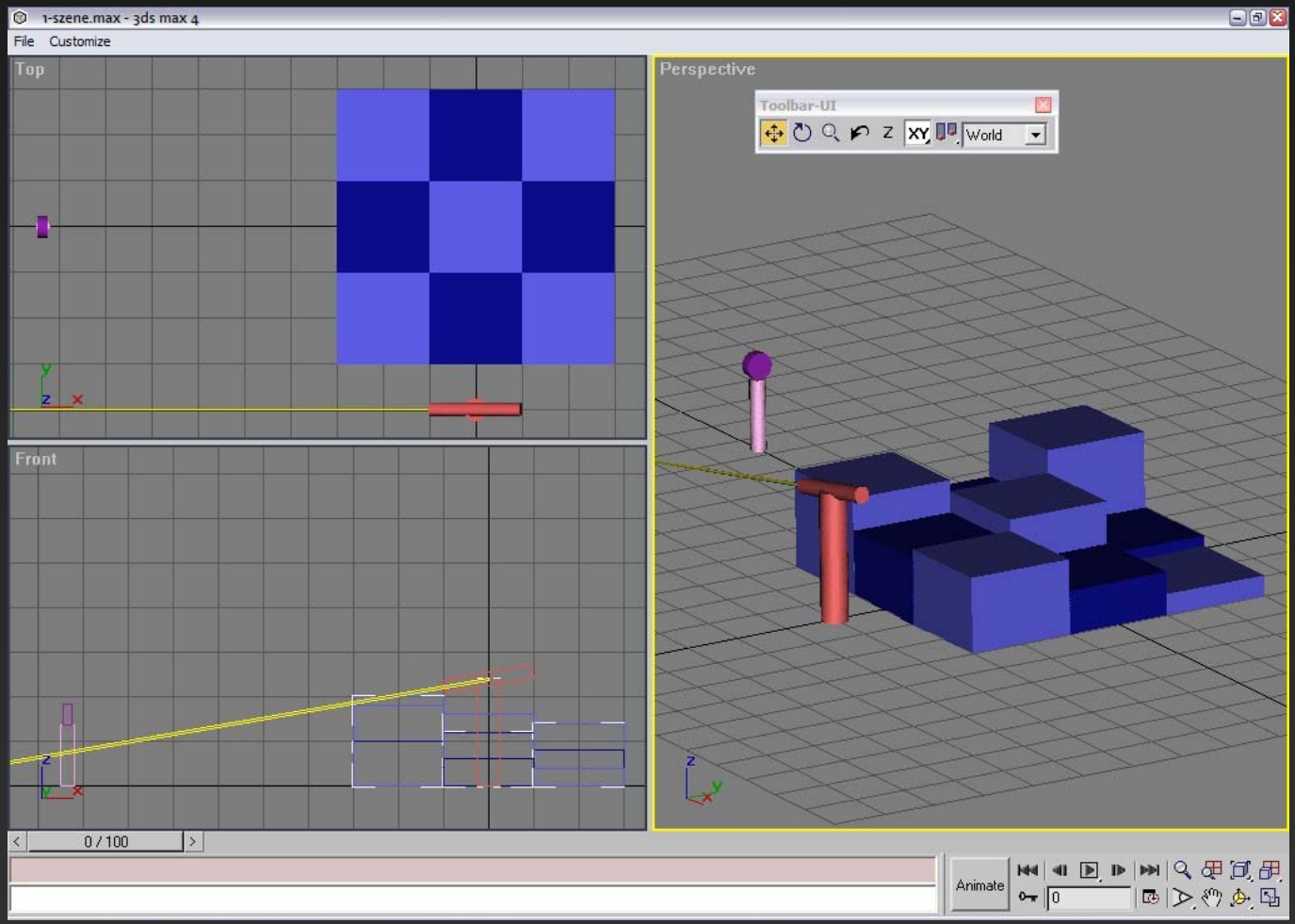
Alternative tools: CAD system

One more alternative tools, being either CAD, modeller, or architecture tools:

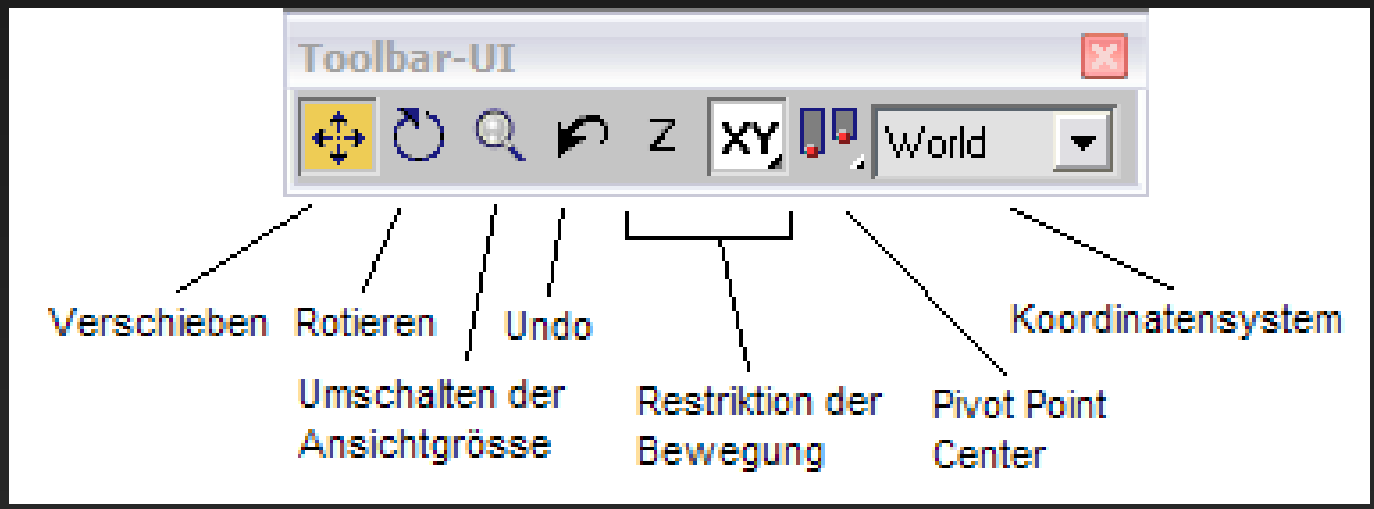
- AutoCAD, or
- Inventor, or
- 3D Studio Max, or
- Maya

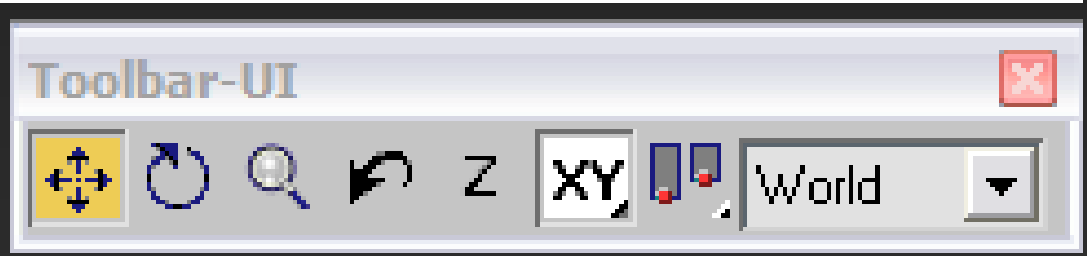
We chose 3D Studio Max

3D Studio Max – three views

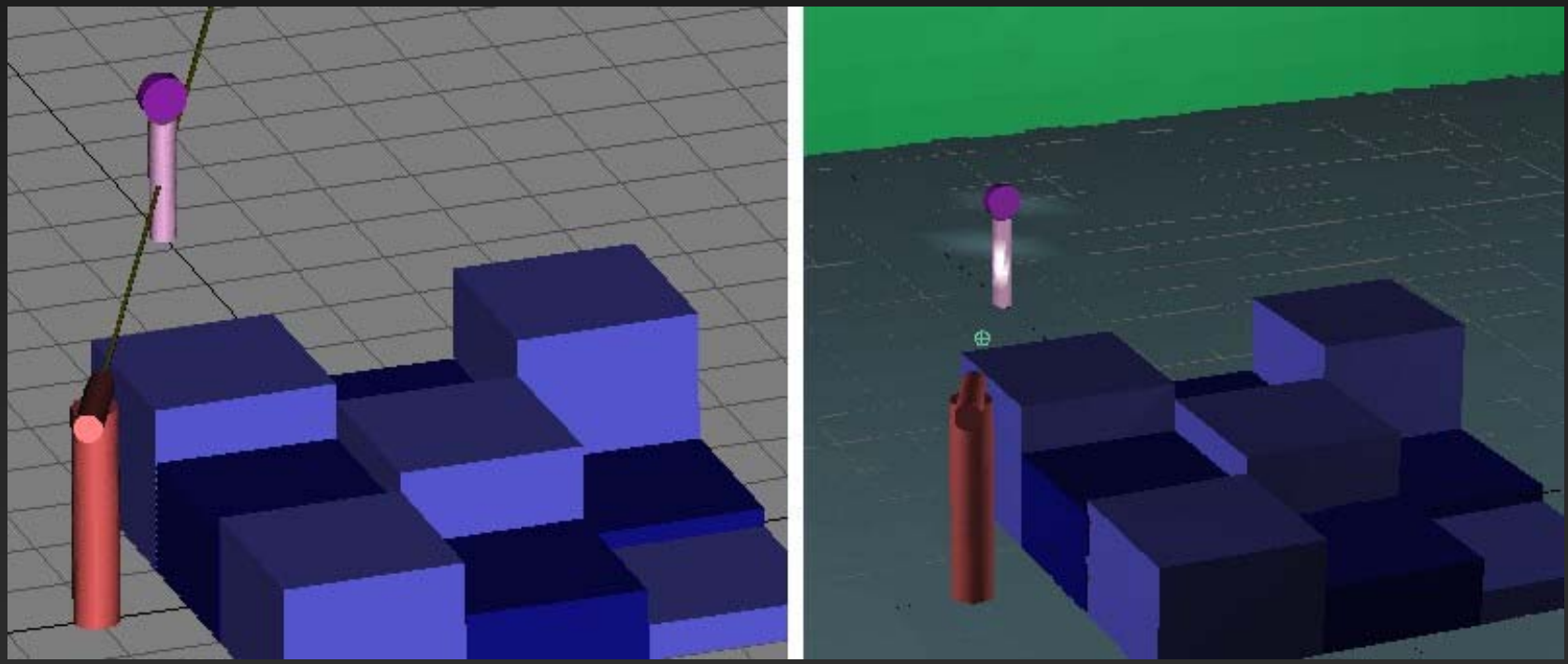


3D Studio Max – interactive support





3D Studio Max – laser beam



Paper at:

www.fjeld.ch/pub/ISMAR2002b.pdf