

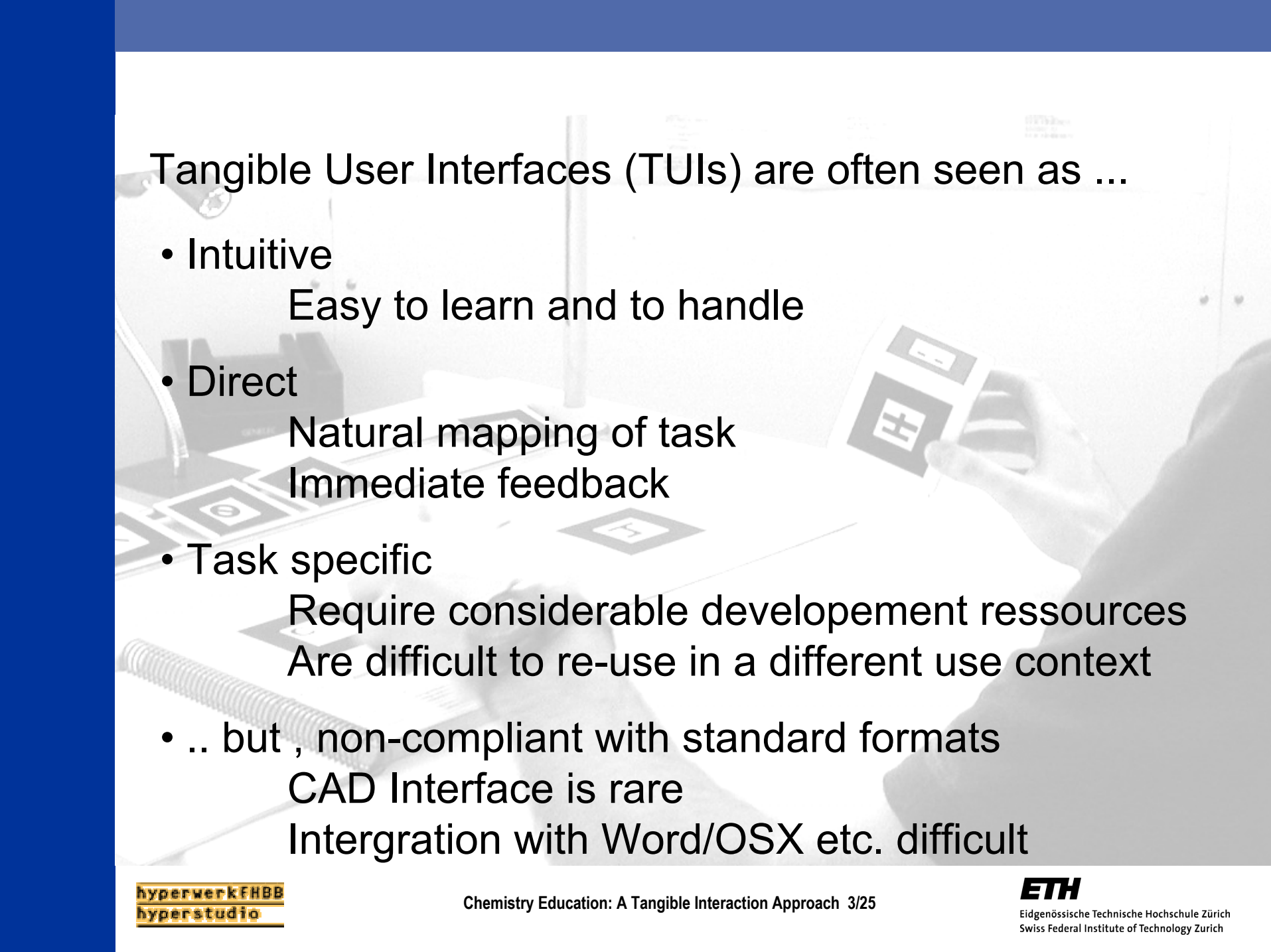
Chemistry Education A Tangible Interaction Approach

M. Fjeld, P. Juchli, B. Voegtli
ETH Zurich, HyperWerk FHBB

Overview

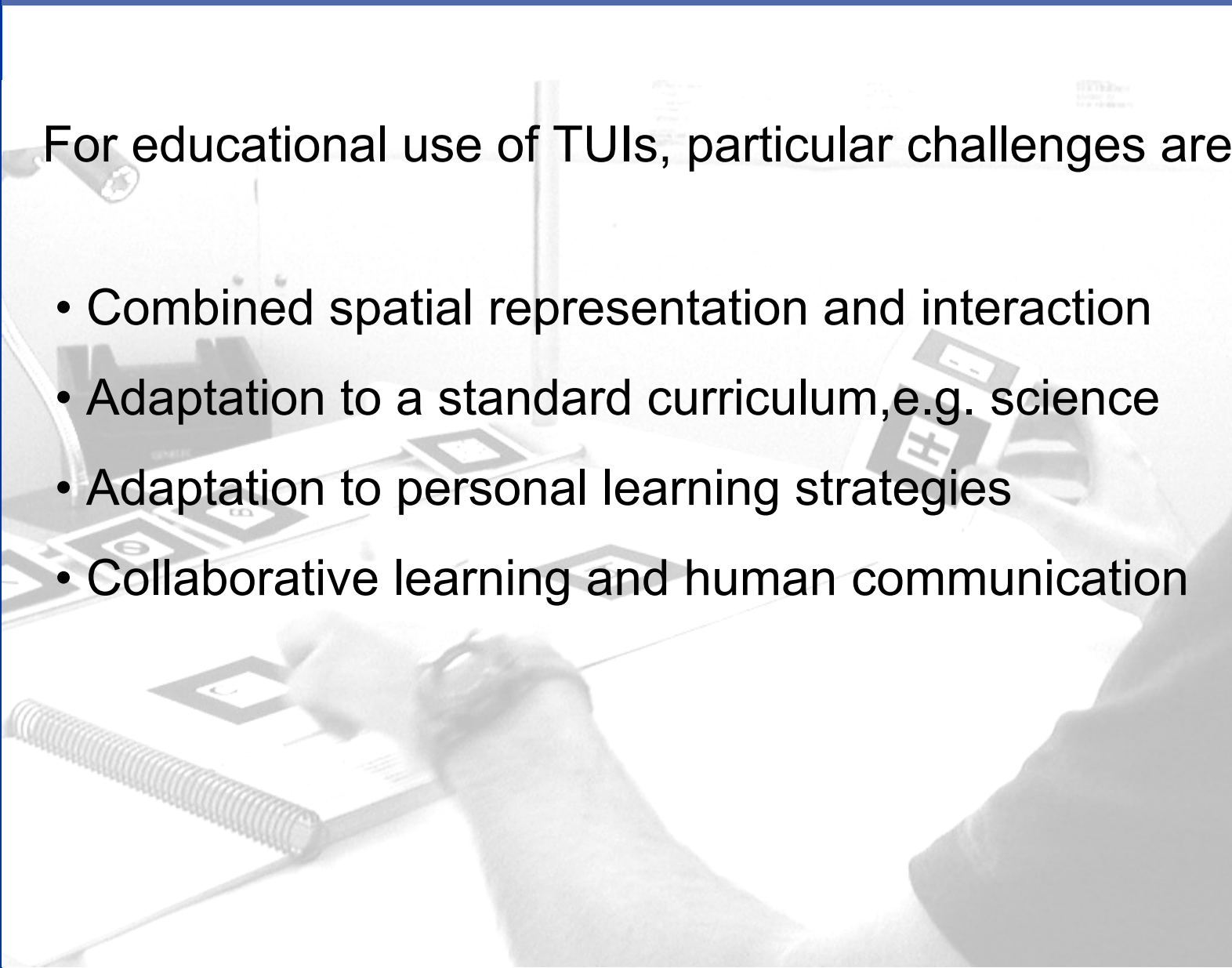
- How Tangible User Interfaces are perceived today
- How TUIs lend themselves to educational use
- Educational context: Molecular modelling
- The Augmented Chemistry system
- Recent advances
- Work in progress
- Credits





Tangible User Interfaces (TUIs) are often seen as ...

- Intuitive
Easy to learn and to handle
- Direct
Natural mapping of task
Immediate feedback
- Task specific
Require considerable development resources
Are difficult to re-use in a different use context
- .. but , non-compliant with standard formats
CAD Interface is rare
Integration with Word/OSX etc. difficult



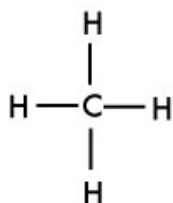
For educational use of TUIs, particular challenges are ...

- Combined spatial representation and interaction
- Adaptation to a standard curriculum, e.g. science
- Adaptation to personal learning strategies
- Collaborative learning and human communication

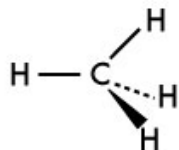
... but TUI for education also promise significant benefits

- Information pieces attached to physical objects help memorize content
- Limitations of time multiplexed interfaces may be overcome through bi-manual (and collaborative) use
- Enable non-linear, explorative learning strategies

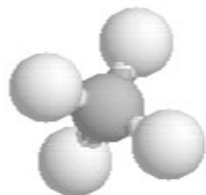
Educational Context in Focus: Molecular models and modelling; intermediate level



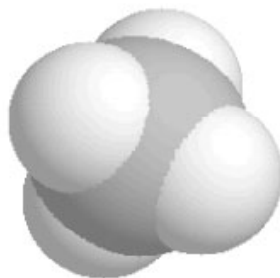
Constitution formula



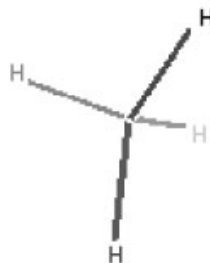
Structure formula



Ball-Stick



Spacefill



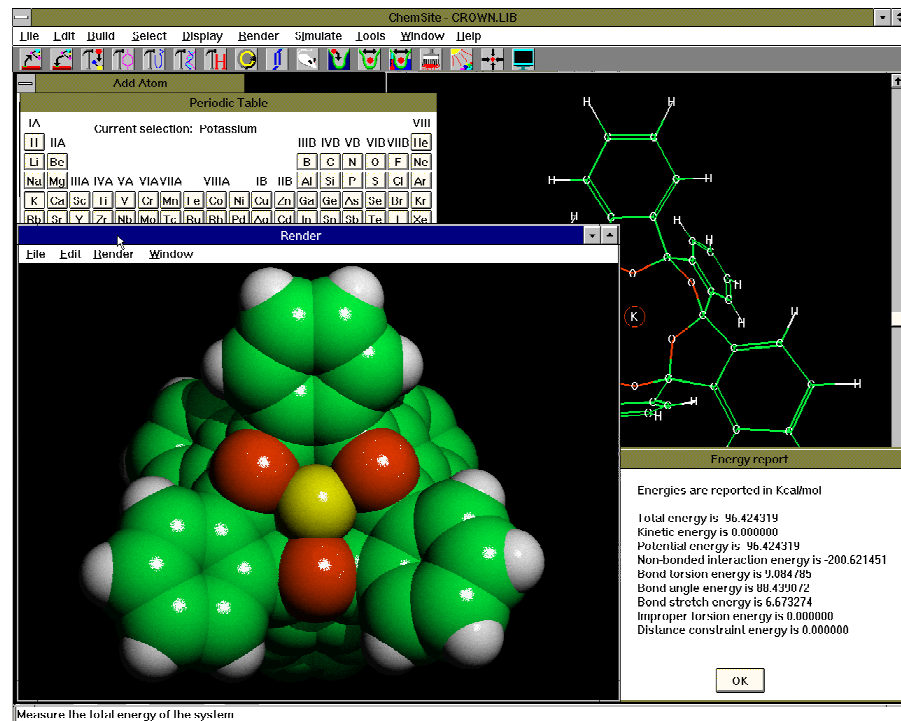
Wireframe

Established tools for molecular modelling

Physical ball-stick kit



Digital spacefill/wireframe GUI



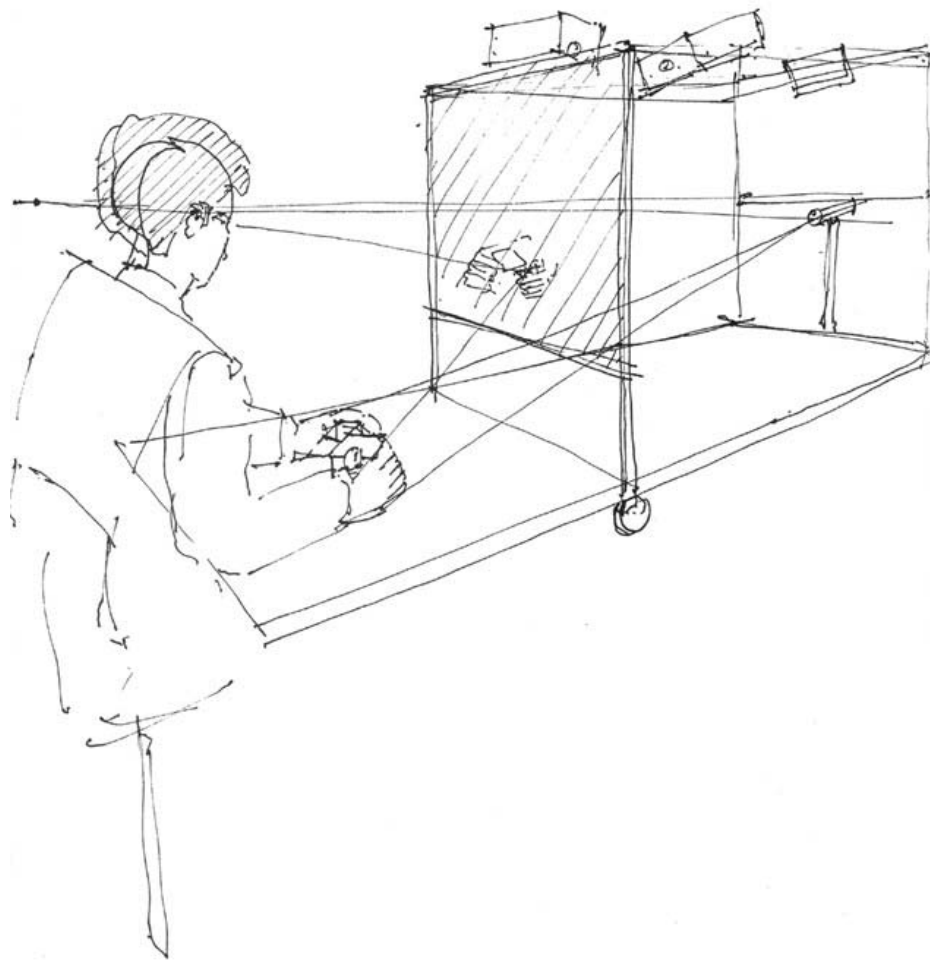
Our strategy in interface design:
Combine the strengths of *physical* and *digital* interface

- Offer direct manipulation of virtual molecular models
- Combine 3D representation and spatial interaction
- Give users audiovisual feedback
- Observe and keep track of user's interactive steps

The Augmented Chemistry (AC) System:

A virtual mirror
as an augmentation
of a tabletop learning
environment

The mirror
is a design
metaphor.
An alternative
would be a user's
point-of-view.

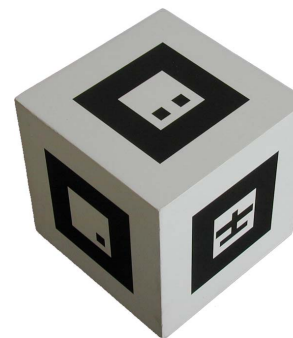




Interactive Tools



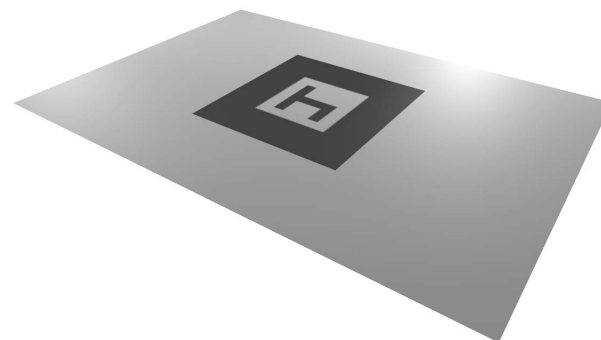
Booklet



Cube

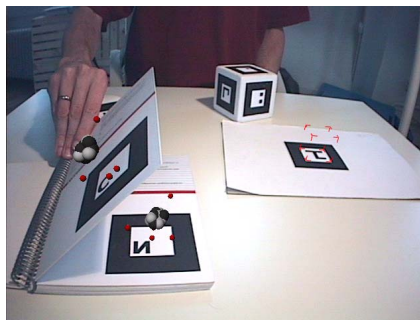


Gripper

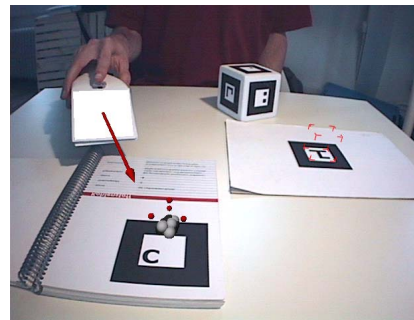


Platform

Interaction Sequence



1. Element selection



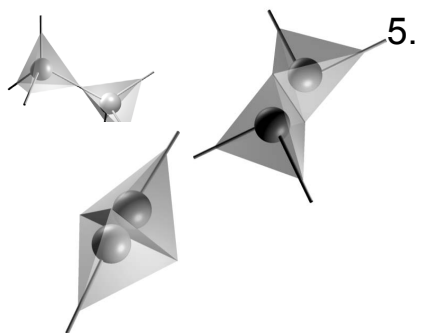
2. Load an element with the Gripper



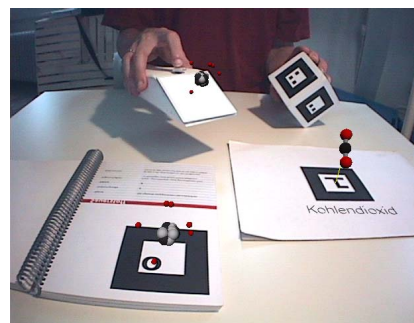
3. Place the atom onto the platform



4. Select binding atom

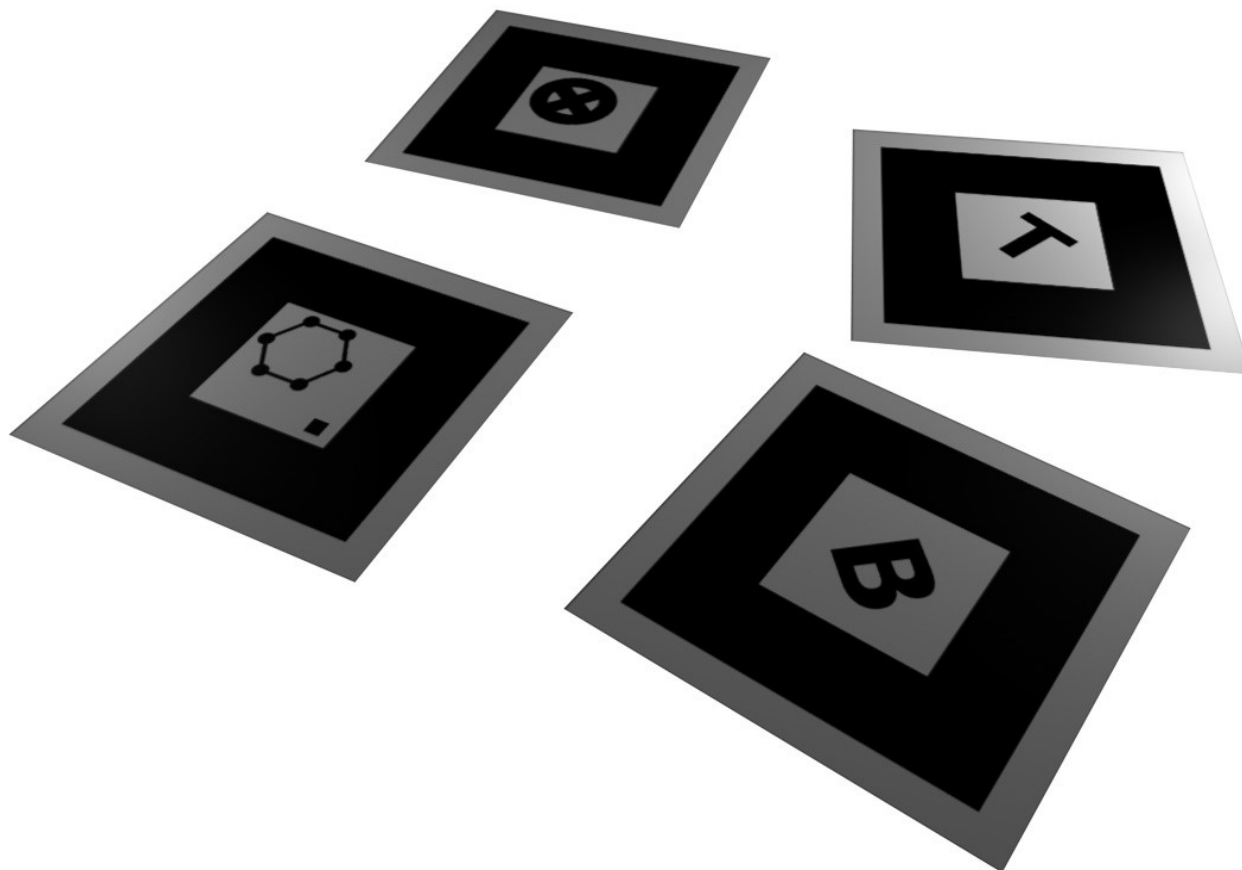


5. Determine single-double or triple binding



6. User feedback after successful completion

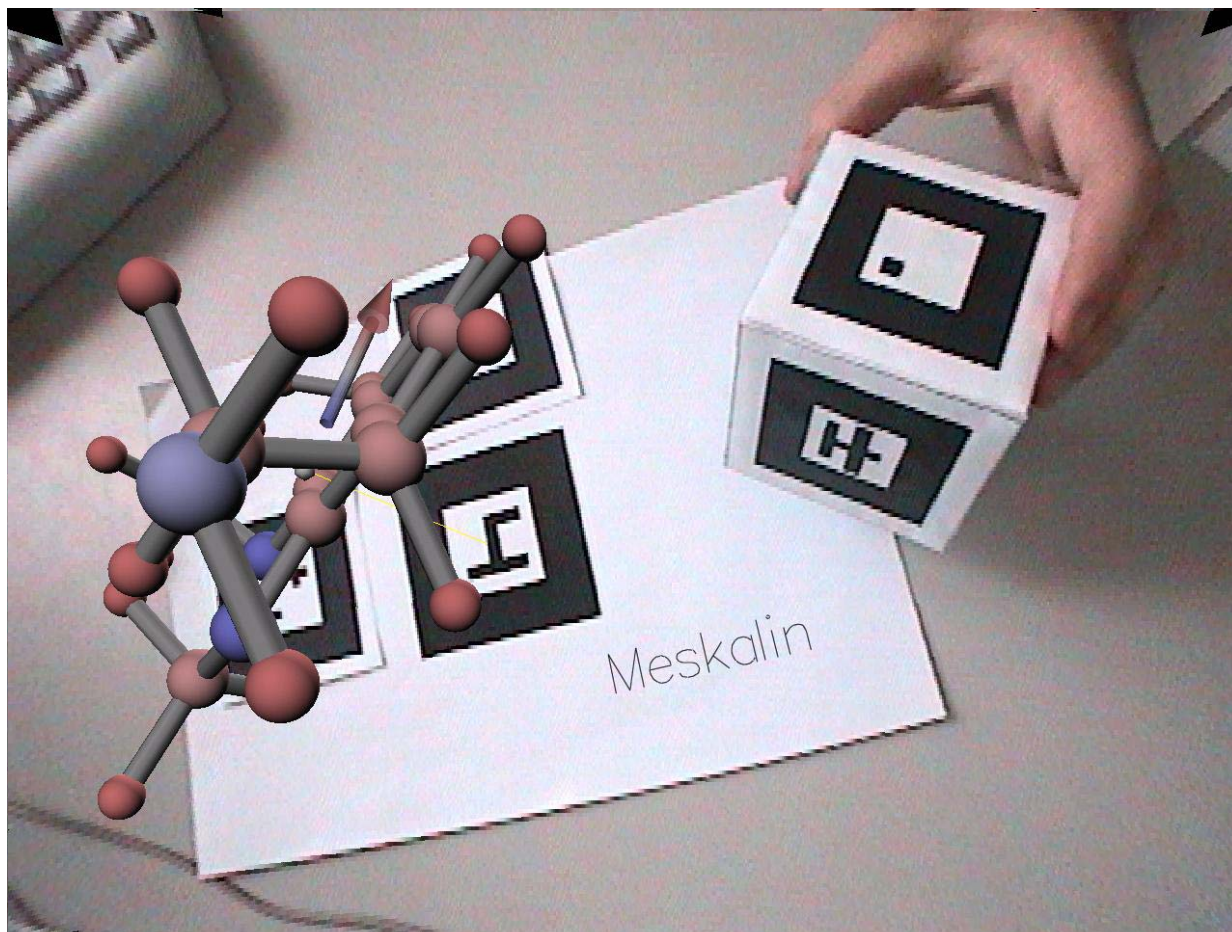
Specialized tools



Recent advances in this project

- Interviews to discover the most beneficial cases for use in chemistry education. The outcome was:
Electronegativity; dipole-moment -> realized
Reaction mechanisms; left-right-handedness;
interface to molecular libraries -> future
- Improved software structure for a sustainable long-term framework with multiple developers
- Describe easily reproducible set-up of PC with Linux graphic-cards and frame-grabber-card

Recent advances: Electronegativity; dipole-moment



Recent advances: Improved Software Structure

4.1 Folder Structure

The Folder Structure is given as follows:

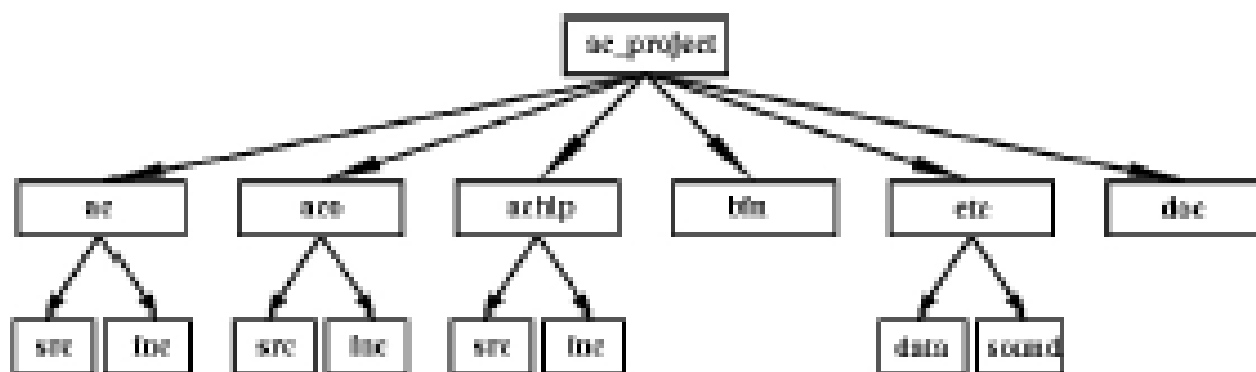
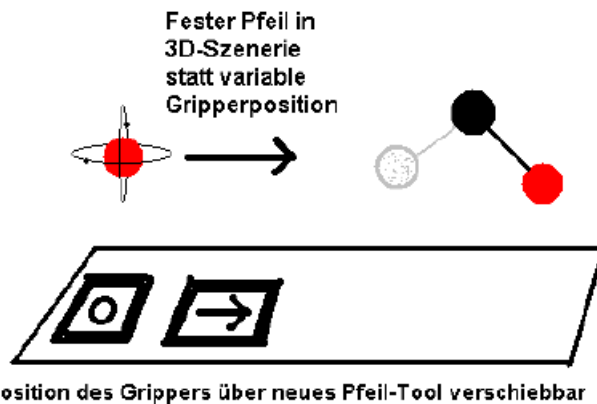


Abbildung 1: Directory Structure

Work in progress: Interactive Aspects

- Replace Gripper
- User study of interaction w. non-dominant hand
- Validate intuitiveness of the mirror metaphor
- Offer PC & Mac version for webcam and cube only

Variante für Ersatz von Gripper



Work in progress: Interactive Aspects

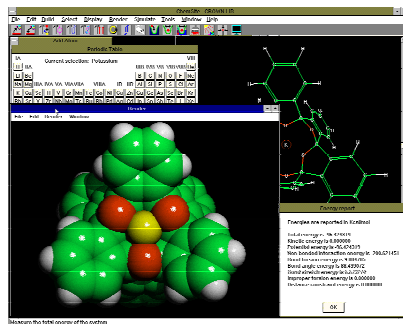
Examine the use of haptic input and/or output devices, e.g.:

- Tactile gloves; input only
- Force feedback gloves; input and output

Products to be evaluated, e.g.:

- Cybergrasp from Immersion.com (2x15.000 Euro)
- Skeleton

Work in progress: Learning Studies



Same task, three different conditions

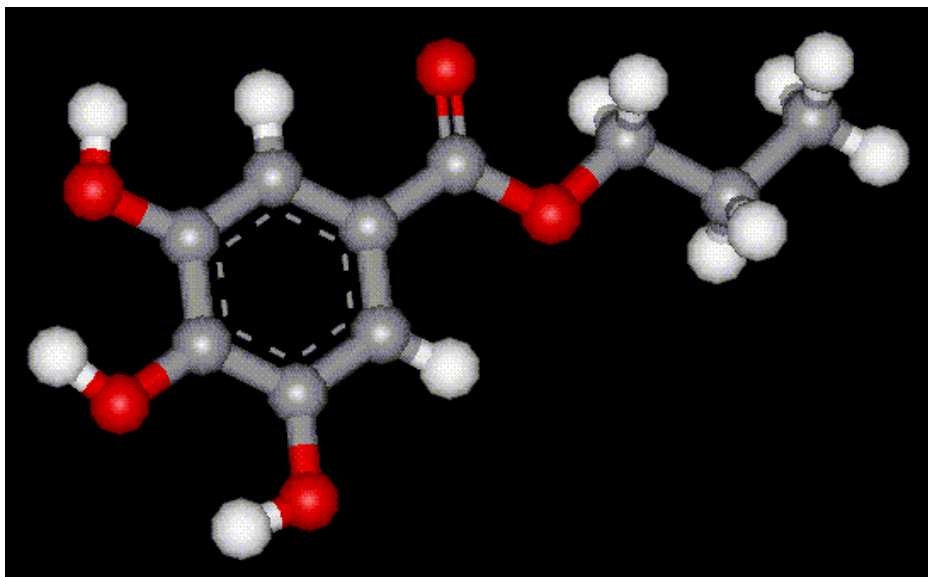
Measurement of:

- Task completion
- User satisfaction
- Task load (NASA task load index)

Work in progress: Organic Reaction Mechanisms

- Reactions mechanisms are:
Substitution, Addition, and Elimination
Bi-products and/or catalysers can play a role
- Potential benefit of TUIs to reaction mechanisms:
Rotate the involved parts in the reaction
Play forward and backward
Set time resolution
- A typical example is esterification:
Esters are formed by combination of an alcohol
with an acid, with water molecule taken out.

Work in progress: Organic Reaction Mechanisms



Esterification: E310 Propyl gallate is synthesised by the esterification of gallic acid. It is used as an antioxidant in food, often with BHT (E321) and BHA (E320).

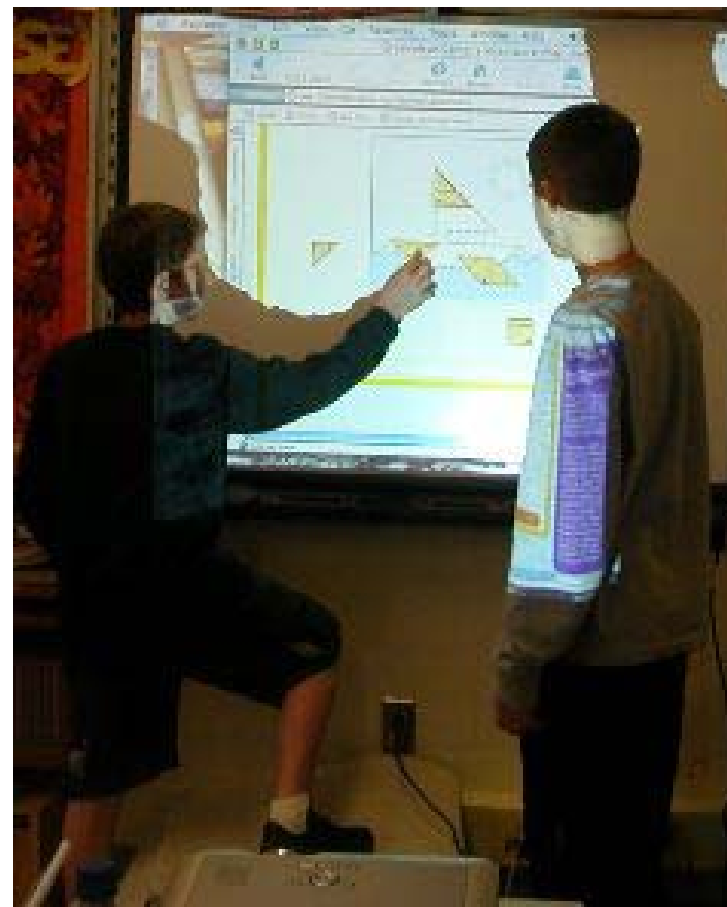
<http://www.chm.bris.ac.uk/webprojects2001/anderson/antioxidants.htm>

Work in progress: Collaborative Aspects



Chemistry education at a university

Work in progress: Collaborative Aspects Rear Projection SmartBoard 1800/18002



Credits



Live in München!

Das AC wird vom Cybernarium in München ausgestellt

Vom 24.11.2003 bis 11.01.2004

Infos unter www.cybernarium.de