Usability in the Tangible Space

International Conf. on Artificial Reality and Telexistence 2004
Tangible Space Initiative Workshop

Gerard J. Kim
Virtual Reality & Perceptive Media Laboratory
POSTECH, Korea

Tangible Space: Ambitious!

- **Ubiquitous Computing**
  - Network
  - Sensors, Context Awareness and AI
  - Miniaturization and Embedded Hardware
- **Mixed Reality**
  - (Somehow) Seamless Connection between the virtual and real (physical) → AR …
  - Tangible and direct interaction
    - Probably usable … Really?
    - Can everything be tangible and direct?
- **What kind of Services?**

Philips' NEBULA

- Nebula is an interactive projection system designed to enrich the experience of going to bed, sleeping and waking up.
- It provides an intuitive and natural way of physically participating in a virtual experience, through simple body movements and gestures.
- The aim was to create an atmosphere in the bedroom that encourages and enhances rest, reflection, conversation, intimacy, imagination and play.

NEBULA: Interaction

- Pebbles
  - Content is selected by placing a smart ‘pebble’ into the bedside pocket.
  - Each pebble corresponds to a different topic or theme.
  - They change according to day and time.
- Others
  - Alarm and time
  - Messages
  - Games

NEBULA - The System

- Nebula consists of a ceiling projector linked via the Internet to a database of content.
- Once users have selected the content for projection, they can manipulate it simply by adjusting their sleeping positions and interacting with their partner while in bed.
- Since the dynamics between individuals are random and unpredictable, the flow of content created by the couple will be unique and specific to them.
- In general, the ceiling projection becomes livelier as the participants become more active.

Philips' Intelligent Personal Care Environment - The bathroom cares for you

- Ambient Intelligence in the bathroom:
  → *based on personal preferences, start different applications on an interactive mirror display.*

- Mirror: Display and place of interaction (Special display system to be inserted into the Mirror)
  - Shaver: helping instruction on shaving
  - While brushing their teeth, watch cartoon.
  - Scale: display weight and other info.

Philips' Intelligent Personal Care Environment (2)

- Person and preference recognition (e.g. by weight, height)
- Other means of interactivity: speech control, gesture recognition, etc.
- Wireless connection: Low-power RF protocols (ZigBee)
- The health coach sub-system: Measurement and processing of bio data

UNC's OOTF (Office Of The Future)

System that combines and builds upon the notions of panoramic image display, tiled display systems, image-based modeling, and immersive environments.

Better everyday graphical display environment, and 3D tele-immersion capabilities that allow distant people to feel as though they are together in a shared office space.

OOTF: The Approach

- Extract per-pixel depth information
  - For visible surfaces in Office, such as walls, furniture, objects and people.
  - Data acquisition of a distant office using a "sea" of seven cameras

  → Using this depth information one could then display (project) images
  on the surfaces, render images of captured models of the surfaces, or
  interpret changes in the surfaces.

- Tracking of the local user's eye positions
  → Rendering the dynamic model of the remote scene based on the tracked
  user's positions; and a stereo presentation to display a remote collaborator, all dynamically in real-time.

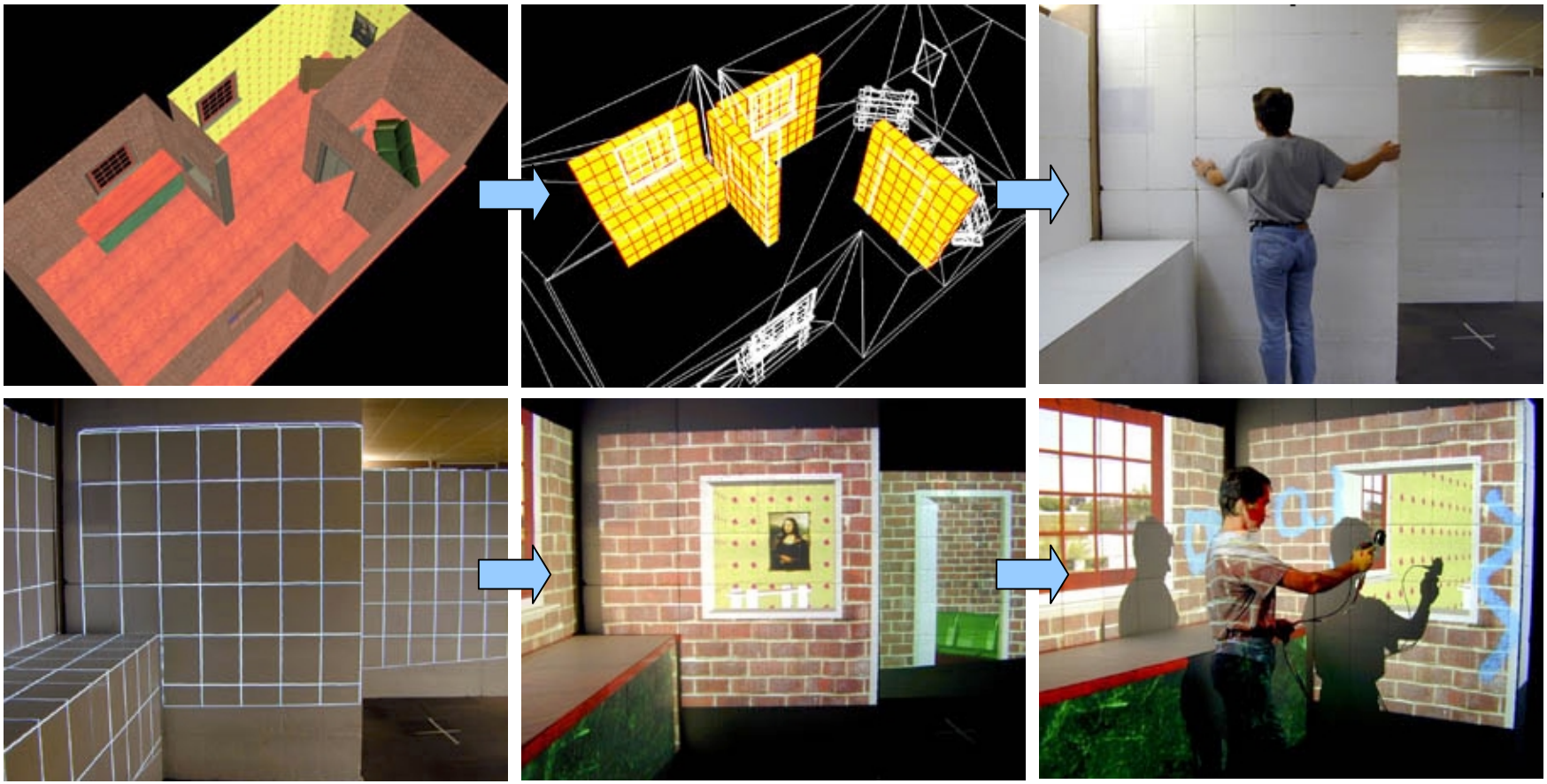
- Projection Display Techniques
  - Automatic and reconfigurable, wide-area display wall.
  - Eight projectors, with computer-controlled pan, tilt, and zoom

UNC's "Being There"

- A projector-based approach to visualizing re-creations of real and imaginary sites.
- To achieve re-creations that are both visually and spatially realistic and provide users a strong sense of immersion as they walk around the virtual site.
- Use simple white building blocks to build static physical model that approximates the geometry of the site, and project dynamic imagery onto the blocks.
- ADVANTAGES
  - very wide field of view,
  - real walking around,
  - reduced sensitivity to tracking errors and system latencies,
  - auto-stereoscopic vision,
  - natural addition of augmented virtuality,
  - provision of haptics.

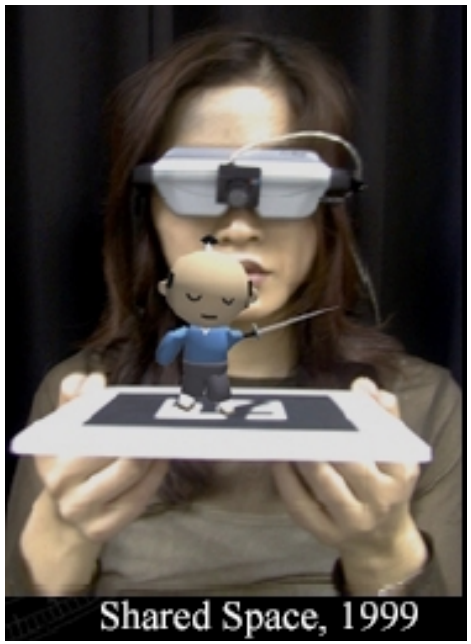
UNC's Group Tele-immersion

Being there - Example



HITLab-NZ: Hybrid Information Space

This work explores how a hybrid collection of input and output devices can be used to collaboratively explore virtual information spaces. We will construct a large stereoscopic projection screen and then develop software that will enable handheld and tablet PCs to drive the display and serve as the main interaction tools. In this way information display can be spread across several different devices enabling a mixture of private and public display in a collaborative setting. The most appropriate display can also be used for different types of data – for example, tablet PCs for 2D data display and stereo projection for 3D.

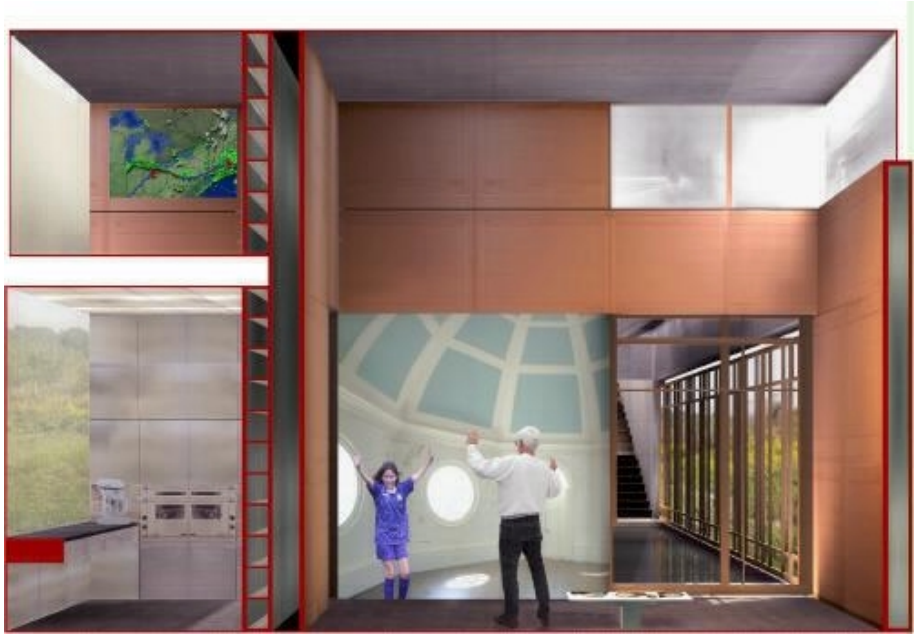


Shared Space, 1999

MediaLab Europe: iCom

- A multipoint awareness and communication portal for connecting remote social spaces
- iCom is a media installation that forms a bridge between different locations. It operates in a continuous and background mode, integrated with the surrounding space. The portal enables awareness of remote activity and promotes a sense of connection among those generating it.
- Its normal mode is background, providing continuous ambient awareness between all stations, but at any time it can be transformed into a foreground mode for ad-hoc tele-meetings or casual interaction, without the need to dial telephones or wait for connections to be established.

Changing Places/House_*n*
The MIT Home of the Future Consortium



- House_n investigates how new computational design, fabrication, and sensing tools can be used to create responsive, adaptable environments that will better accommodate complex new activities and ever-changing technologies.

- Researchers are focused on three application areas: health (proactive environments for healthy living), energy (scalable strategies for Net_0 houses), and mass customization (chassis/infill for places of living).

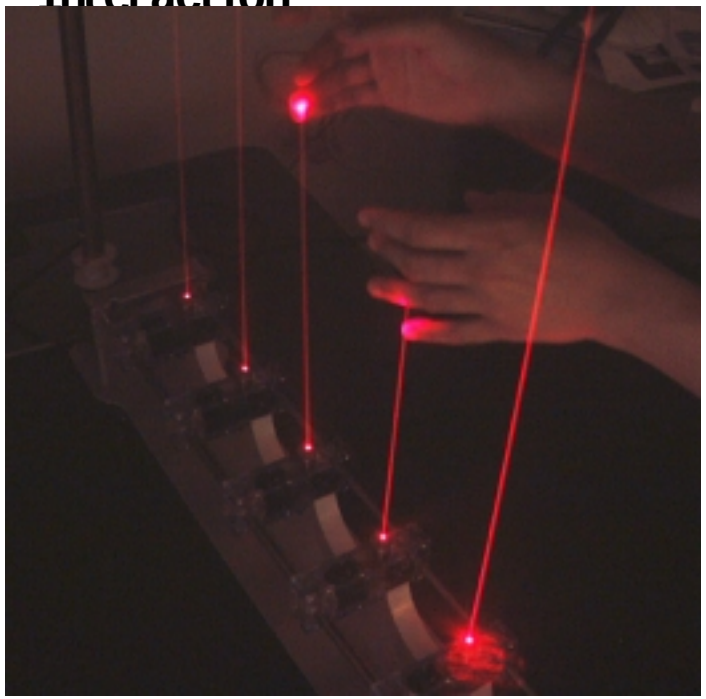
MediaLab: Responsive environment group

The LaserWall

The magic carpet

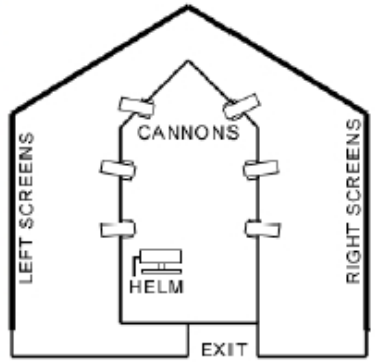
Responsive environment group (2)

Visual Guides for Musical Interaction

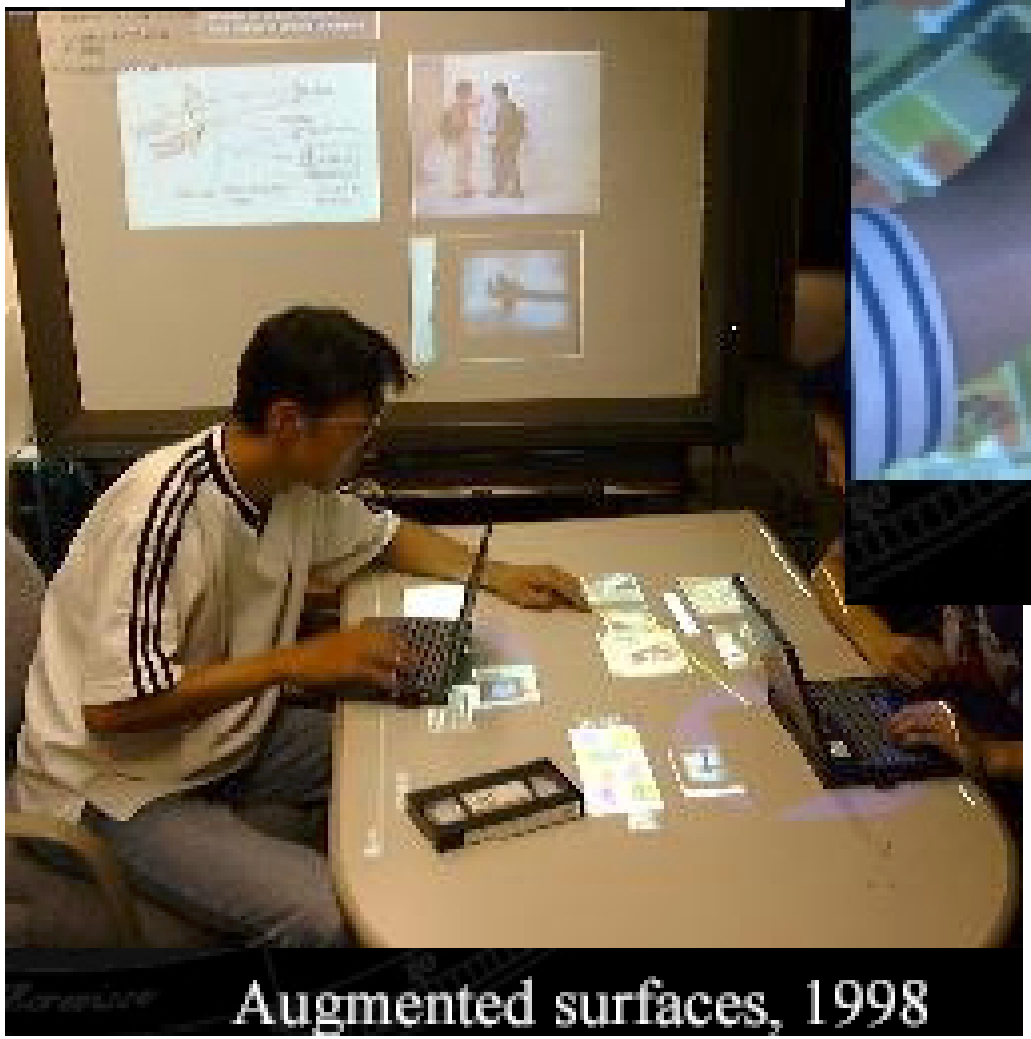


Musical Navigatrics

Disney



SONY/ATR, Japan



KIST: Tangible Space Initiative

Keywords and Observations

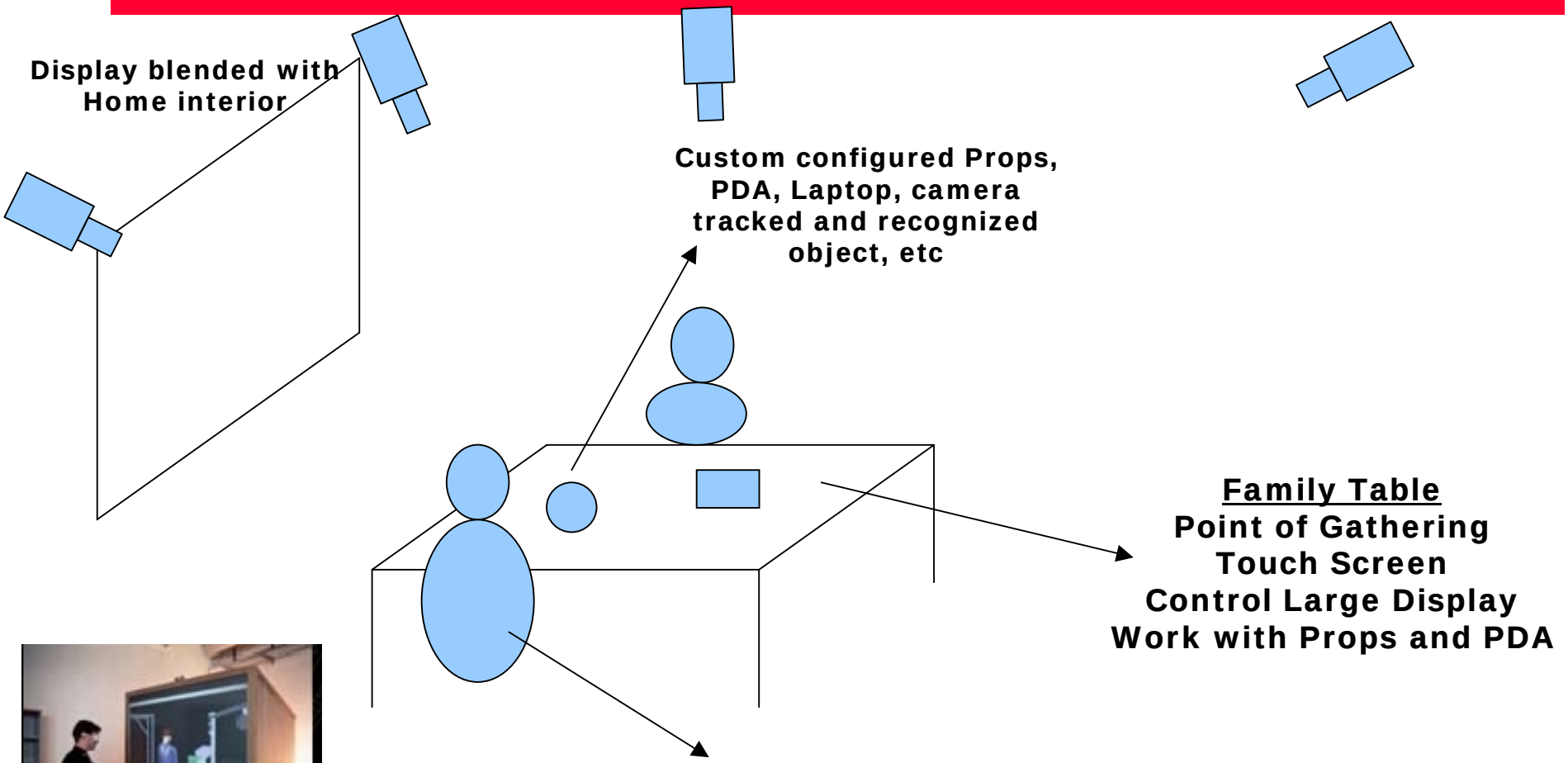
- Interaction
  - Props and Reconfigurability
  - Whole body tracking and location tracking
  - Context sensitive
  - Pattern Recognition / Voice Input

- Display
  - Mixed Reality (Seamless connection between display and real world)
  - Strategically located (Arbitrary surfaces and odd locations)
  - Object centric

- Applications and Visions
  - Customized
  - Communication, Health, Education, Enhance atmosphere

- Other Issues
  - Usability: This is the grand goal!
  - Platform: Can we use Windows on the Mirror?

Proposal: Living Room of the Future ?

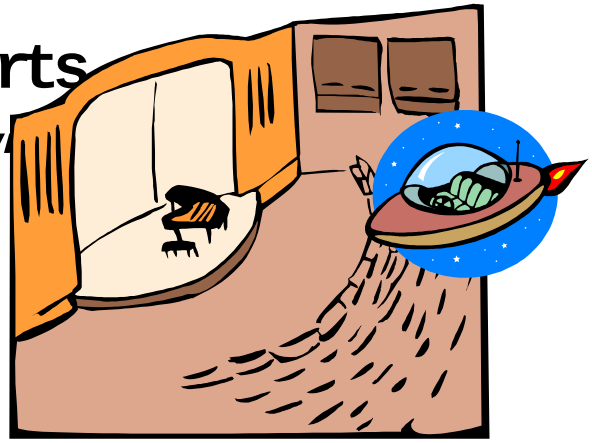


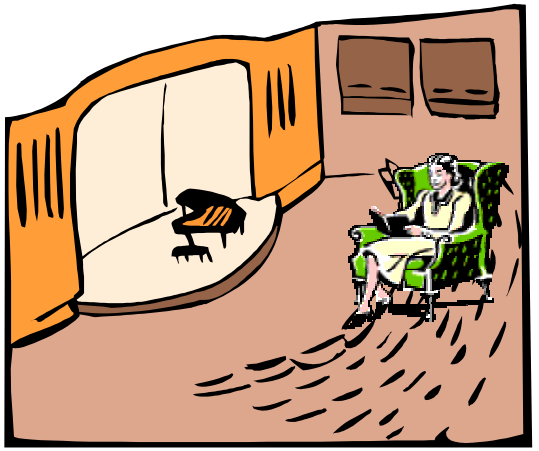
Concept 1: Table-top computing

- **4~ 5 users (vs. 1 user Desktop)**
- **Not really collaborative**
- **Shared physical space**
- **Tabletop metaphor**
  - Fighting for the remote
  - Would you pass the salt?
  - Casual and decorative

Concept 2: Spaceship Metaphor

- **Take me "out" to the ball park …**
- **At home ("in"), with all the comforts**
- **Continuity between "out" and "in"**
  - Augmenting the "out"
  - Augmenting the "in"
- **Presence: Where am I?**





Infrastructure

- Interaction
  - Communication Protocol and System Software
  - Reconfigurable Props
    - Intelligent RF Switch Devices (e.g. tap, press, breath, pressure, etc.)
    - Embedded System Software
  - PDA Interface
  - Touch screen Interface
  - Whole body Interface

- Sensing
  - Network of Cameras (1D, 2D, 3D, marker tracking)
  - Tracking of whole body
  - Family member recognition and location tracking

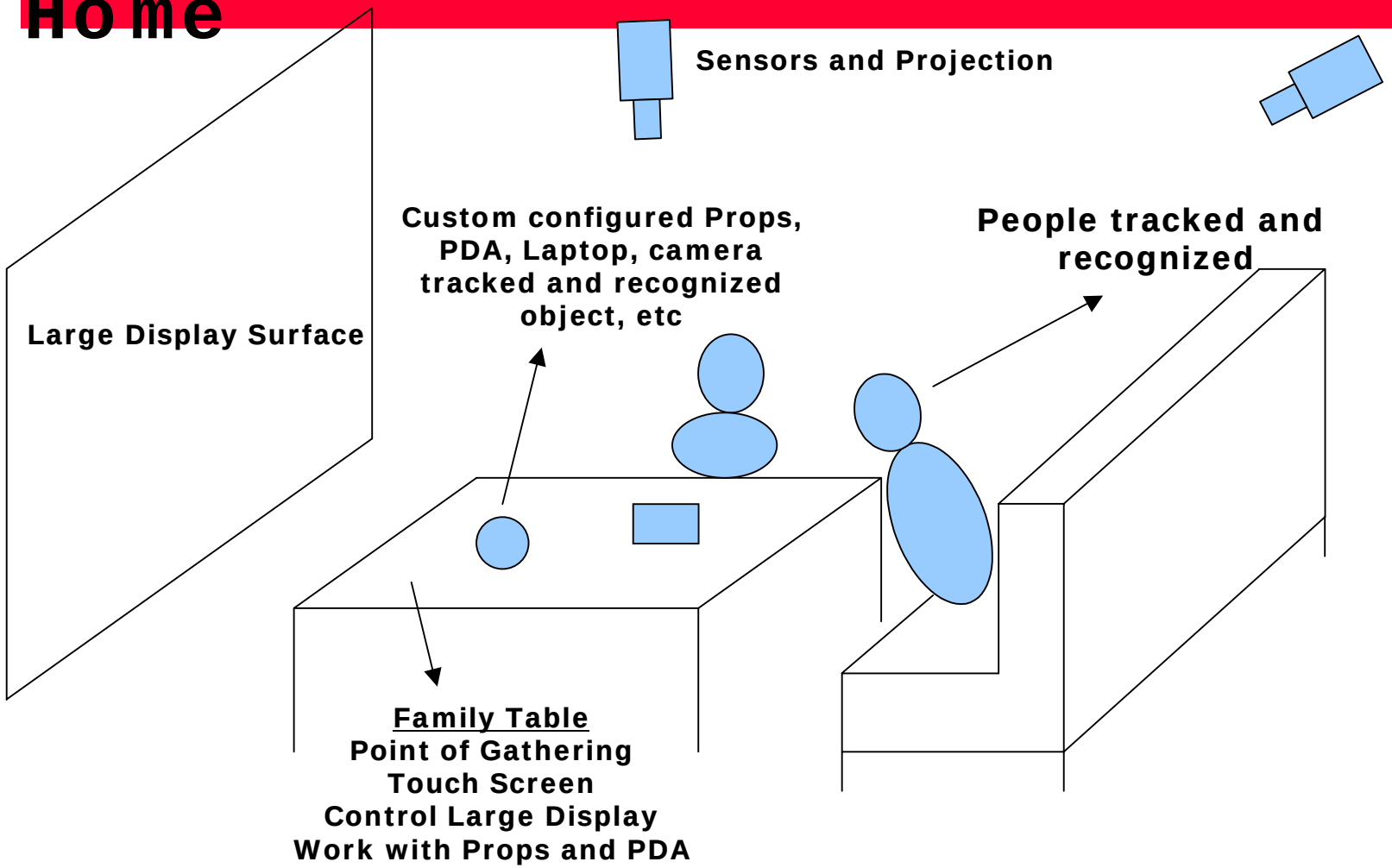
- Simple Context Sensitivity
  - Proximity
  - Identification

- Display and Rendering
  - Table-top projection
  - Object augmentation (blend home with virtual)

Possible applications

- Communication
- Remote presence
- Health
- Education
- Enhance atmosphere (new home concept)

Proposed application: Concert @ Home

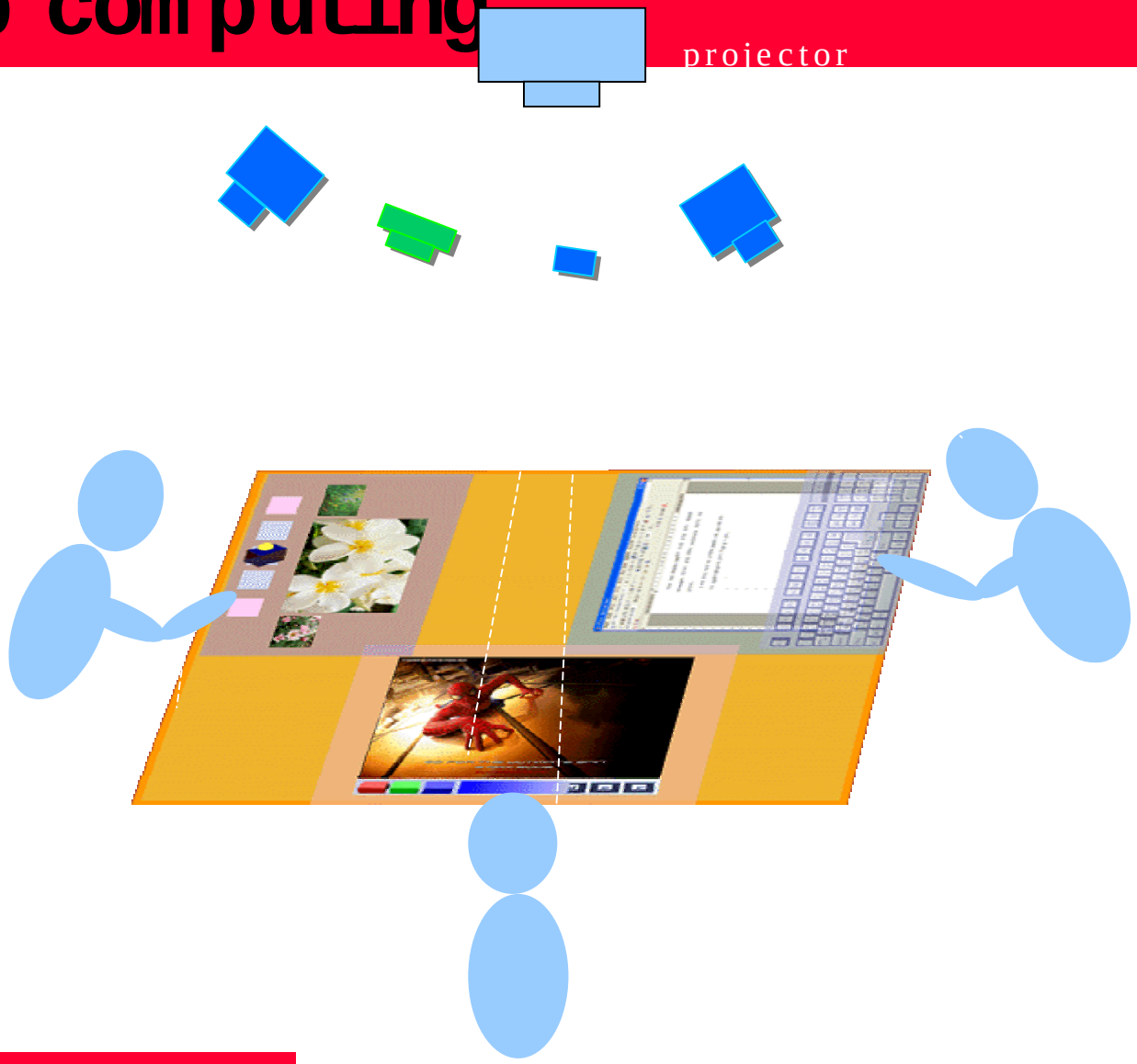


But, actually first problems are:

- **Assessing Usability**
  - What kind of sensors and displays?
  - What are the primitive tasks?
  - What kind of interaction scheme?
  - Sort of a "Chicken and Egg" problem

- **Platform**
  - PDA needs one, and Cell phone has one
  - So do tables … and other forms of ubiquitous computing or interact-able elements

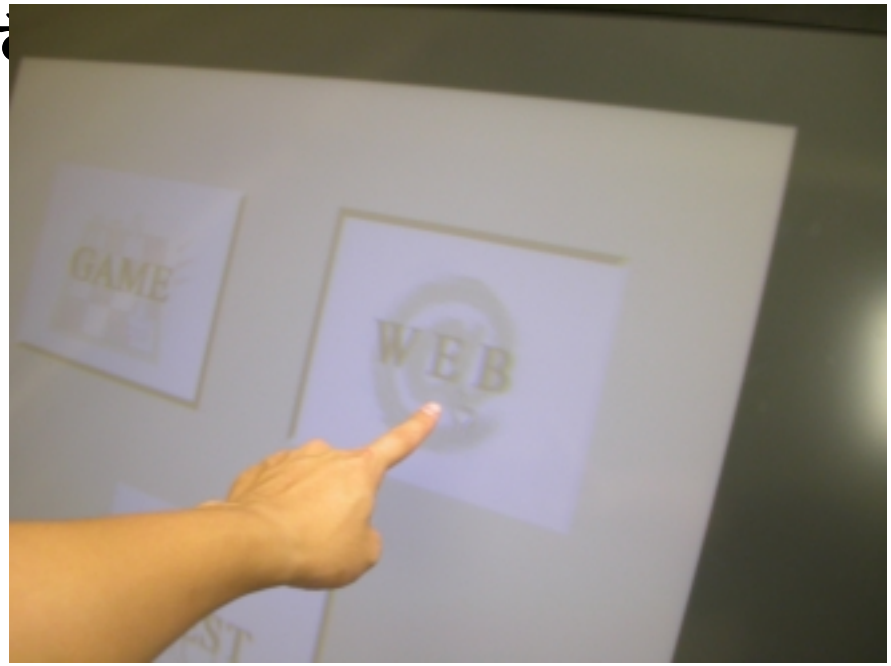
Tabletop computing



Displays and Sensors

- Table display: Rear projection for now
- Hand/Finger Tracking: Camera based (Marker less)
- Prop Tracking (Possibly with a marker)
- Head Tracking (Location only)
- Touch Screen
- OBI (or virtual buttons)
- Voice (Input and Output)
- Simple Motion Gestures and Tabs
- Physical buttons
- PDA, Cell phone, etc.


GAME
WEB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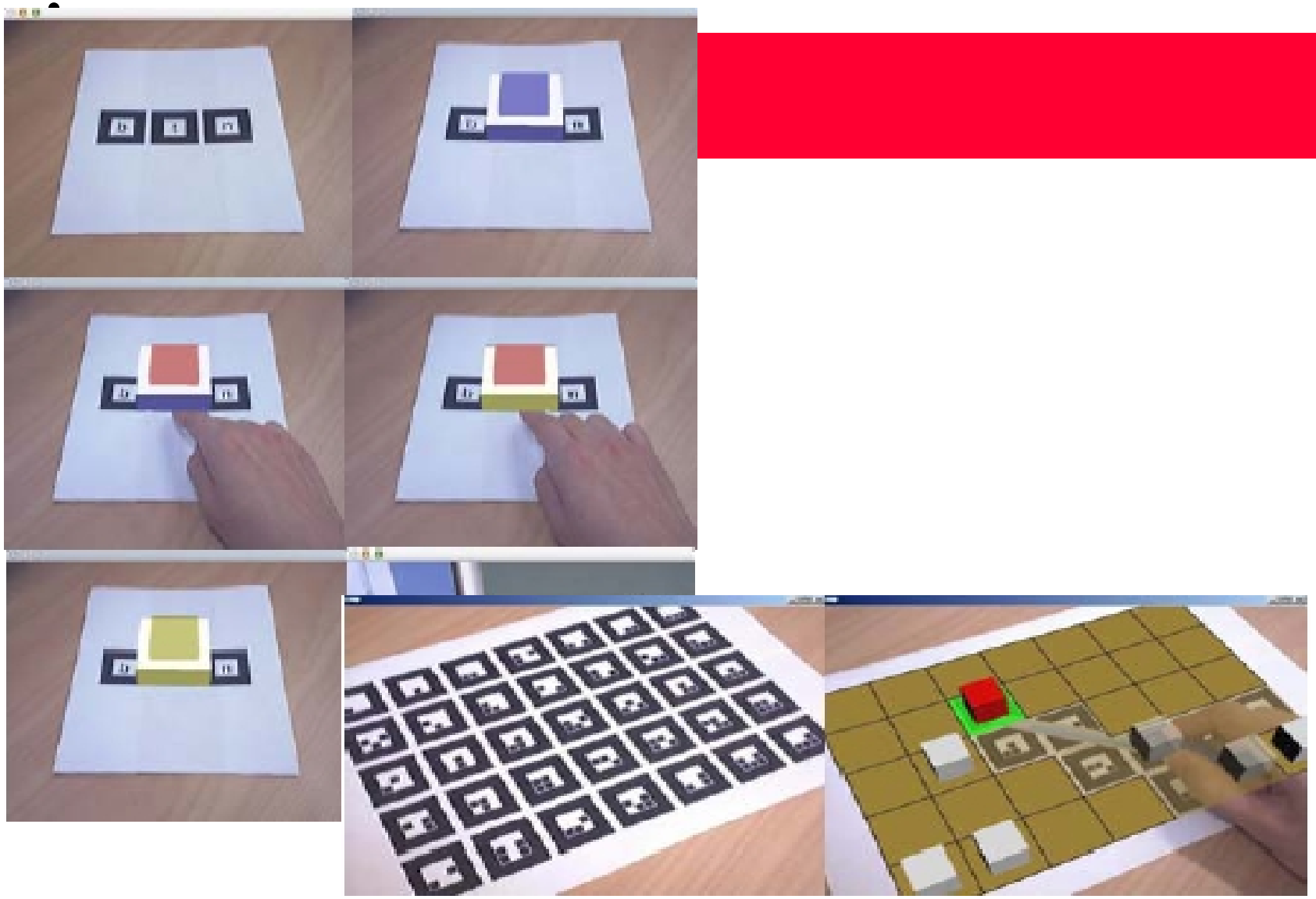
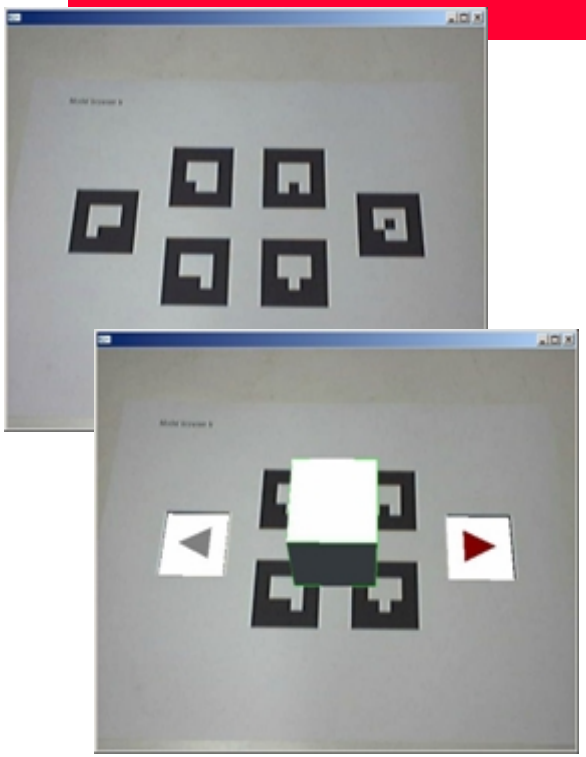
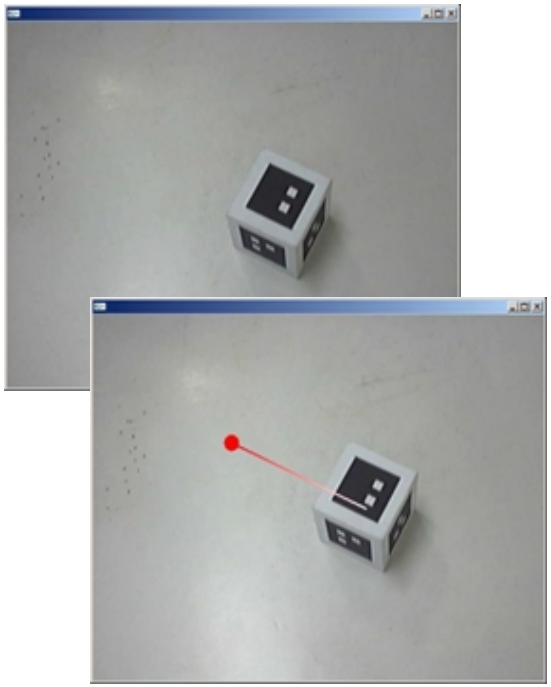
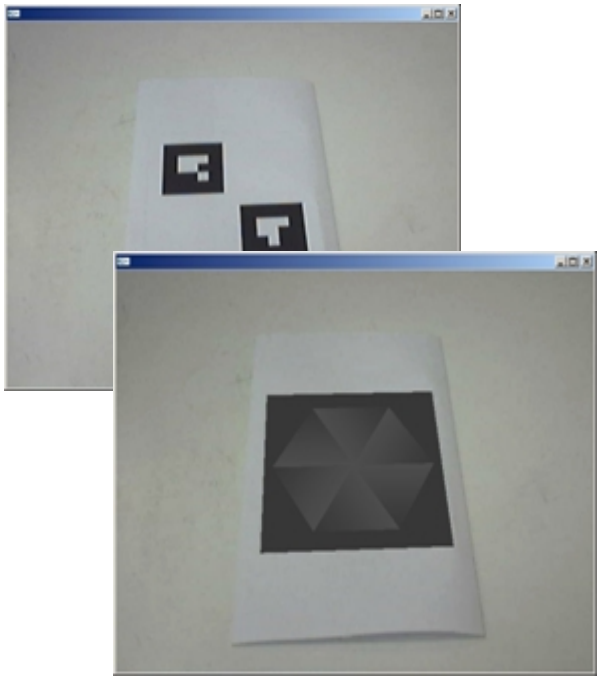




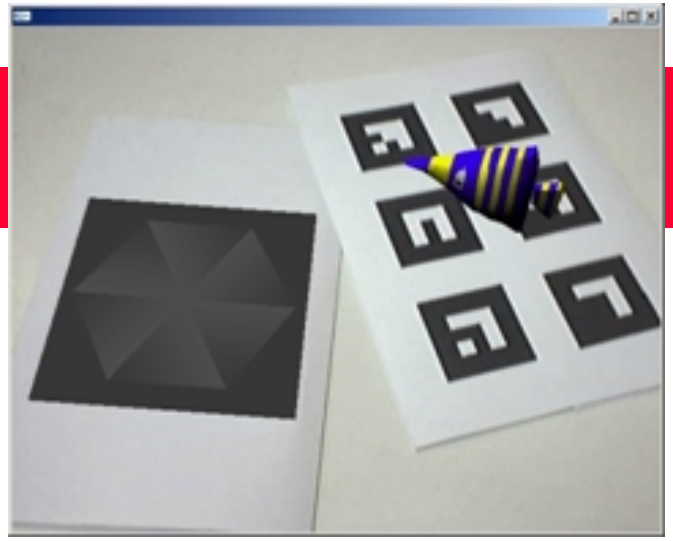
▲ virtual object browser

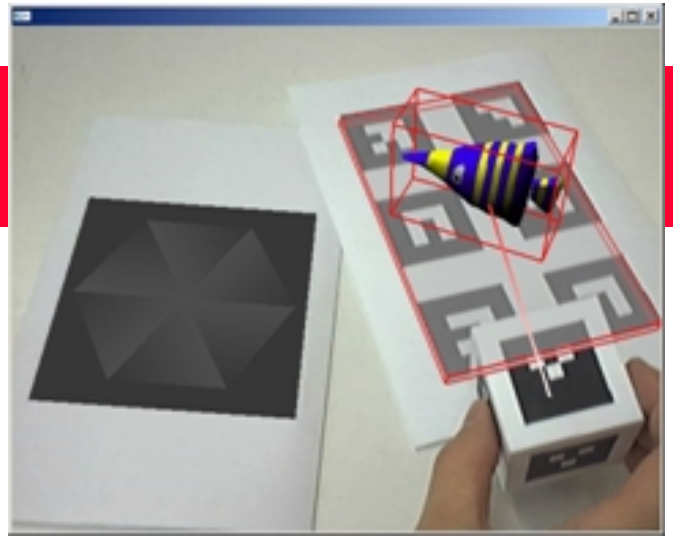


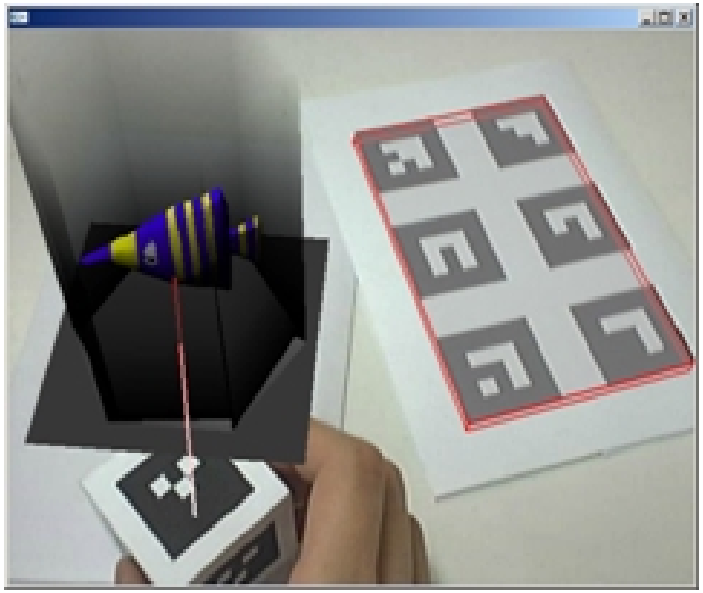
▲ manipulator

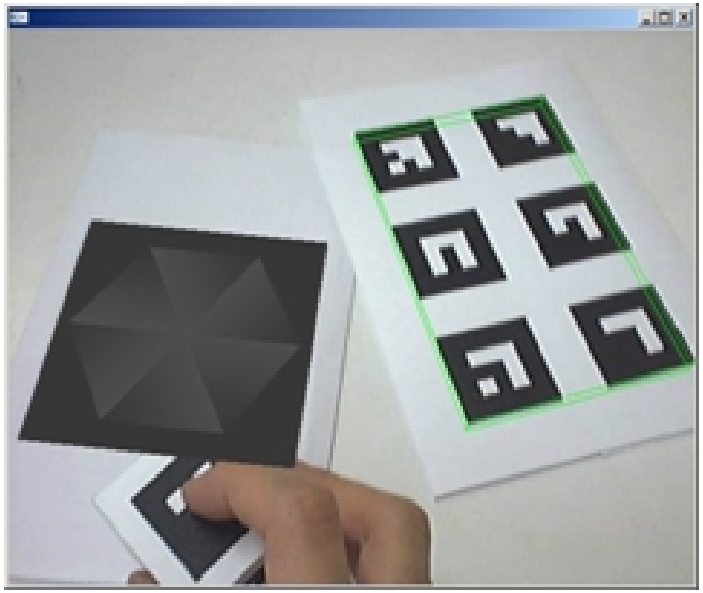


▲ disposer



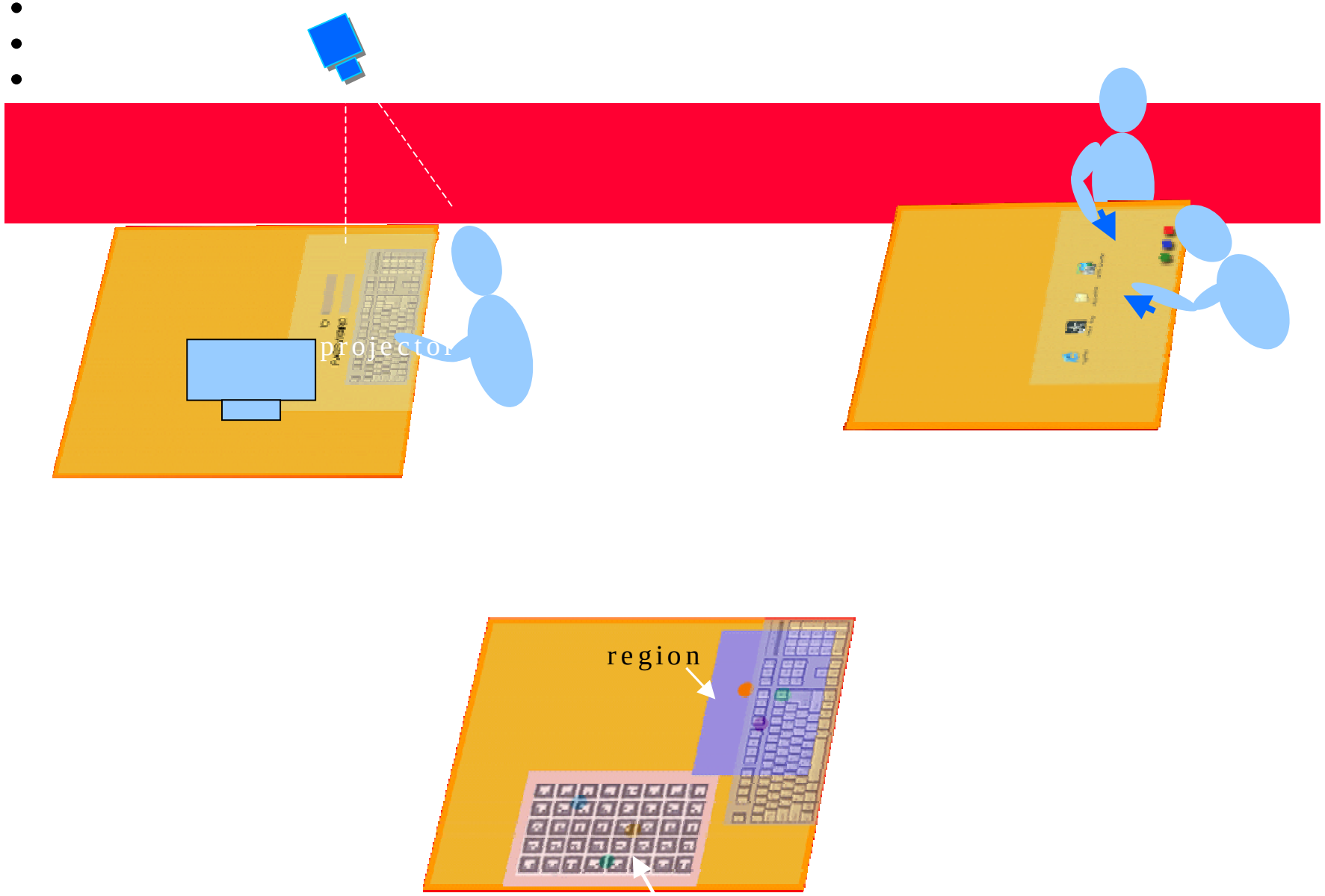


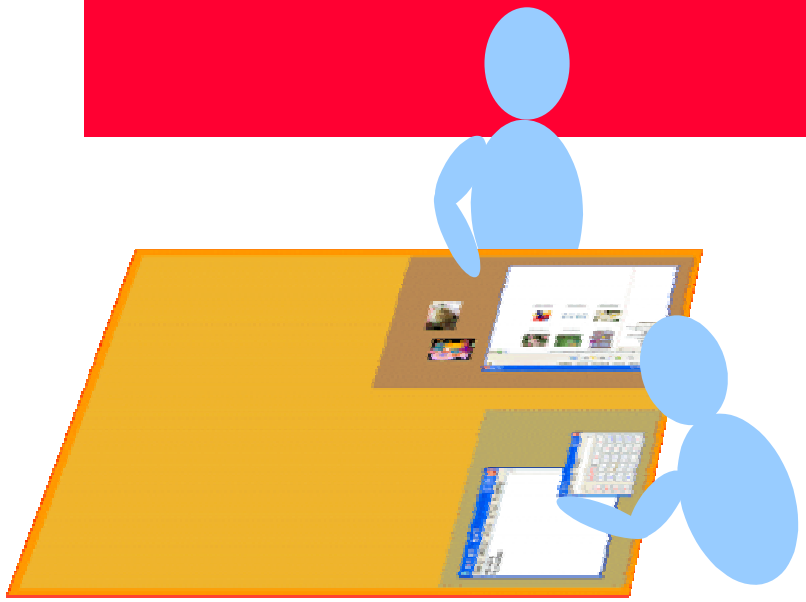


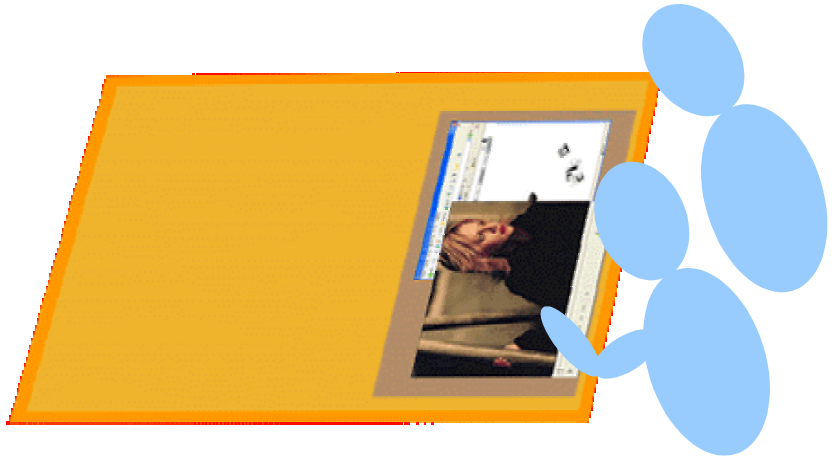


App Manager User Tasks

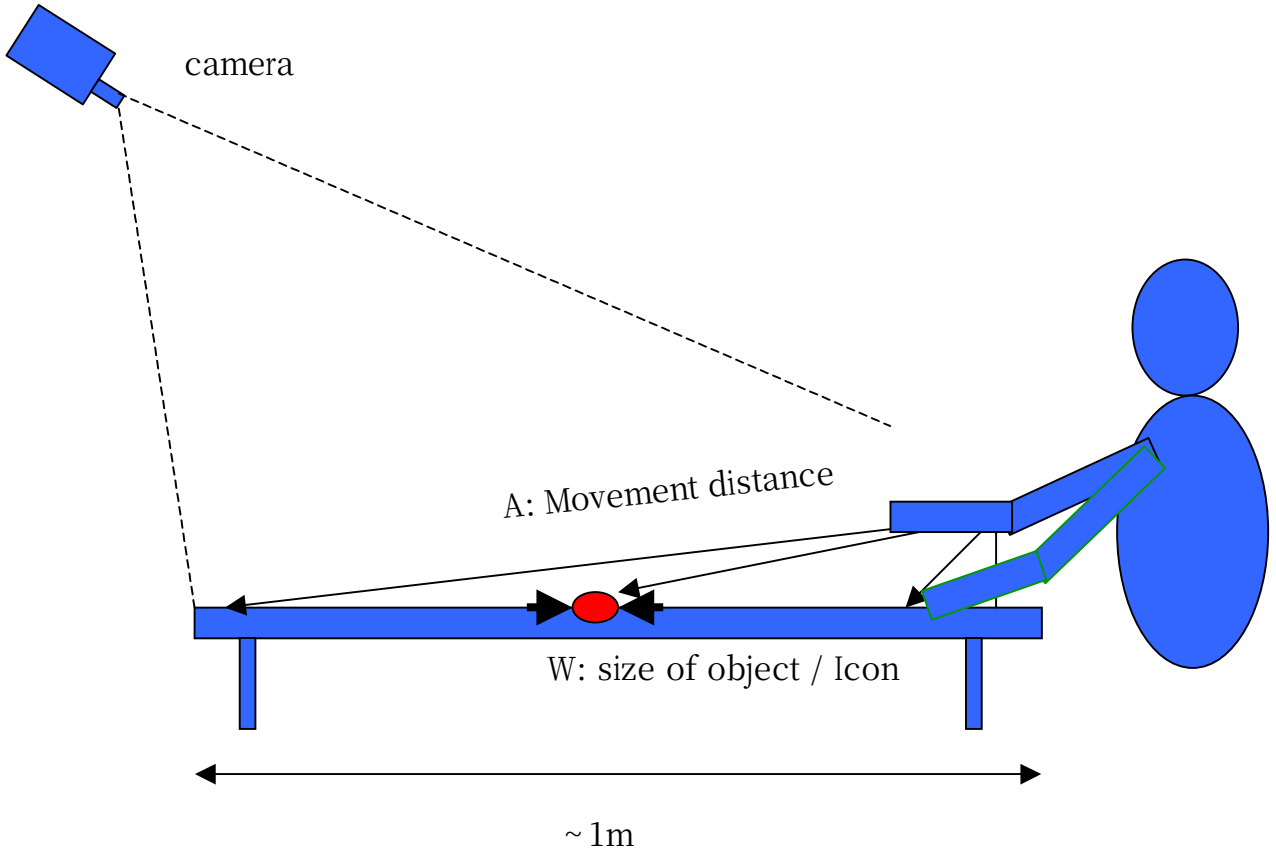
- **System Activation / Deactivation**
  - E.g. Simple touch / Explicit Log-in
- **Object Management**
  - Files, Icons,
- **Region and Resource Management**
- **Display Functions: Orientation and Size**
- **Device Registration**
- **Alphanumeric Input**


projector
region





Fitt's Law: Ergonomics



Selection

- TouchS/Hand-T
  - Close range – Direct Touch
  - Far range – Hand T
    - Ray or Flash (Small flash)
  - GoGo not needed
  - 2 hand not really needed

- TouchS(touched by the prop)/Prop-T
  - Icon need to be size of prop bottom area
  - Prop probably has a button device for final confirmation
  - Close range – Direct Touch
  - Far range – Hand T
    - Ray
    - Flash (Small flash)
  - GoGo not needed / 2 hand not really needed
  - Multiple people – multiple props

Selection

- Mouse (GoGo)
  - Virtual workspace
  - Occludes operating space (→ must be excluded from operating space)
  - Virtual workspace will not work with touch screen or tracking due to resolution

- TouchS/Mouse = TouchS/Prop

- TouchS only
  - Direct Touch all the way
  - Probably need GoGo → inconsistent (finger vs. cursor)
  - Like large virtual space

- Hand-T only
  - Will not work for close range interaction (occlusion)

Selection

- Bring to me and put back
  - Cone selection
  - Close range selection (Touch Screen by hand or by prop)
  - Takes long time
- Localize 1
  - Cone selection
  - Button and go through possible choices

- Localize 2
  - Cone selection
  - Voice (put that there)

Menu invocation (think mouse right button) ~ Discrete event generation (final confirmation)

- Basic menu is already there → Go to Menu Selection (no menu invocation)

- Voice

- Prop Button
  - Need to think about conflict with others
    - Second button
    - Context dependent

- OBI Button (lower right corner?)

- Touch screen button
  - Designated button
  - Double tab?

Final confirmation

- Voice

- Prop Button
  - Need to think about conflict with others
    - Second button
    - Context dependent

- OBI Button (lower right corner?)
  - Follows with my hand (touch screen only)
  - Can it work with remote cursor?

- Touch screen button
  - Follows my hand or cursor
  - Double tab?

Menu Selection (Discrete)

- Voice
  - Go up and down (right or left): Say the item
  - Button and go through possible choices

- Button
  - Go up and down (right or left, rotate)
  - Touch Screen Button (non sense)
  - Touch screen direct select (see below, menu follows hand)
  - Hand OBI

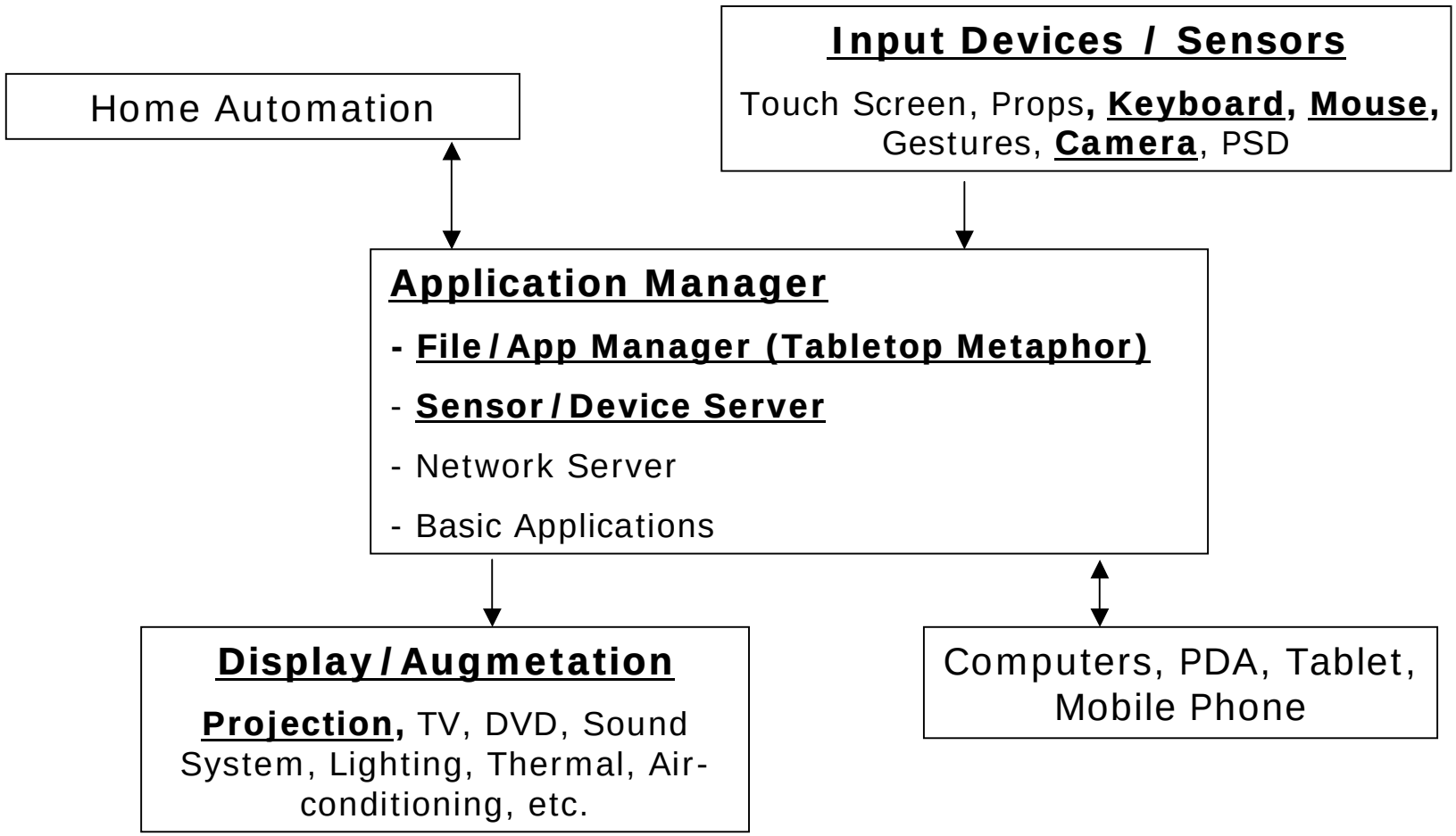
- TouchS
  - Virtual menu movement space
  - Menu follows my hand

- Hand-T
  - Too hard → Cone selection and Voice Voice

Manipulation → "Move Free" Problem → Once Selected

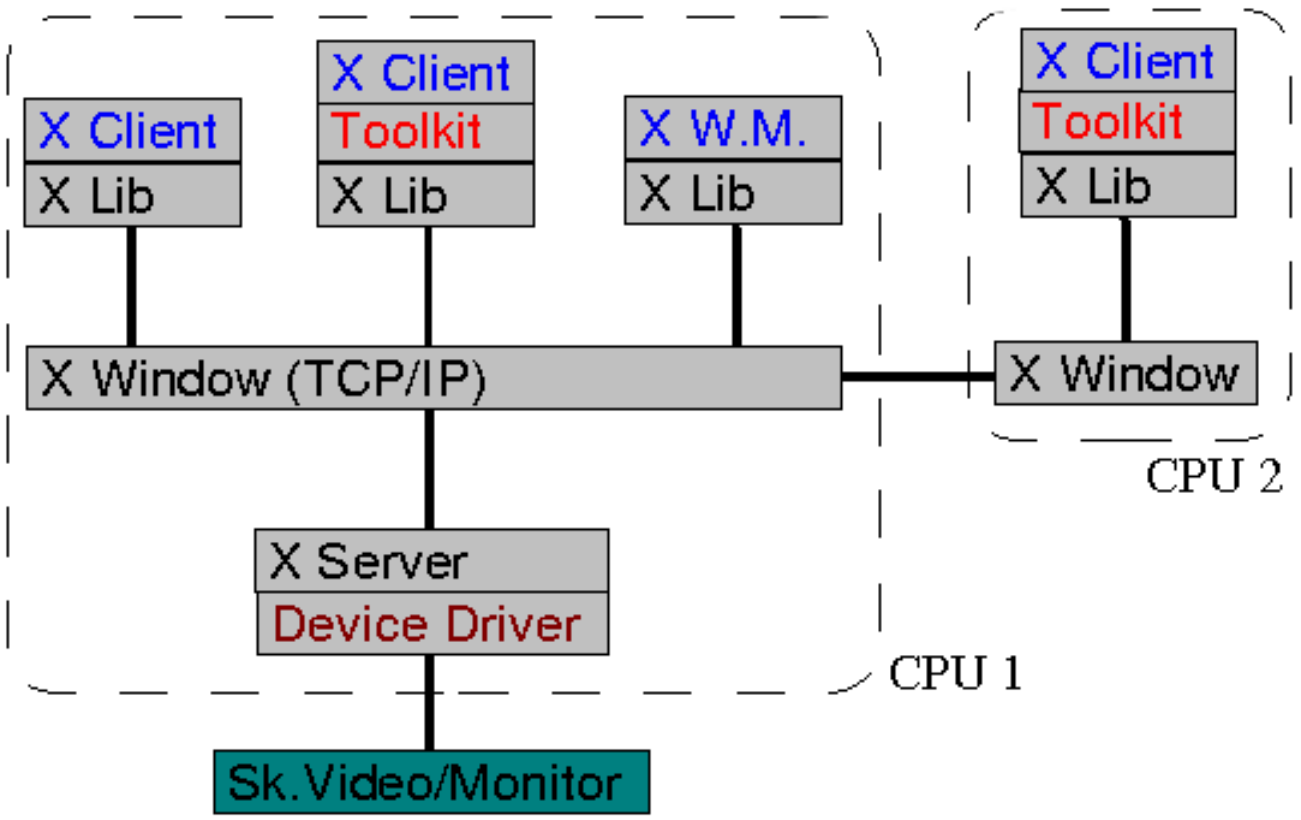
- Need Consistency with Selection!
- TouchS/Hand-T (OK)
- TouchS (touched by the prop) / Prop-T (OK)
- Mouse (GoGo): not good (non linear mapping makes it difficult)
- TouchS only: Human Factors problem
- Hand-T only: Occlusion problem
- Bring to me and put back: TouchS (~ virtual space)
- 2 hands: Rotation!

Platform Functionality: ~ Windows



Architecture: X Windows

- Just build a X window manager!
- Our own X windows like system (for future flexibility)



Conclusion

- Usability is important! But overlooked!

- Assessing usability is difficult
  - Devices
  - Multimodality
  - Physical constraints
  - People problem

- Need to be integrated into the developmental platform

- Usability in the large (Table → Living Room → Home → ?)