

# **User Interfaces**

## **Touch Panel Displays**

### **Visual Imaging in the Electronic Age**

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**Lecture #17**  
**October 25, 2012**  
**Prof. Donald P. Greenberg**

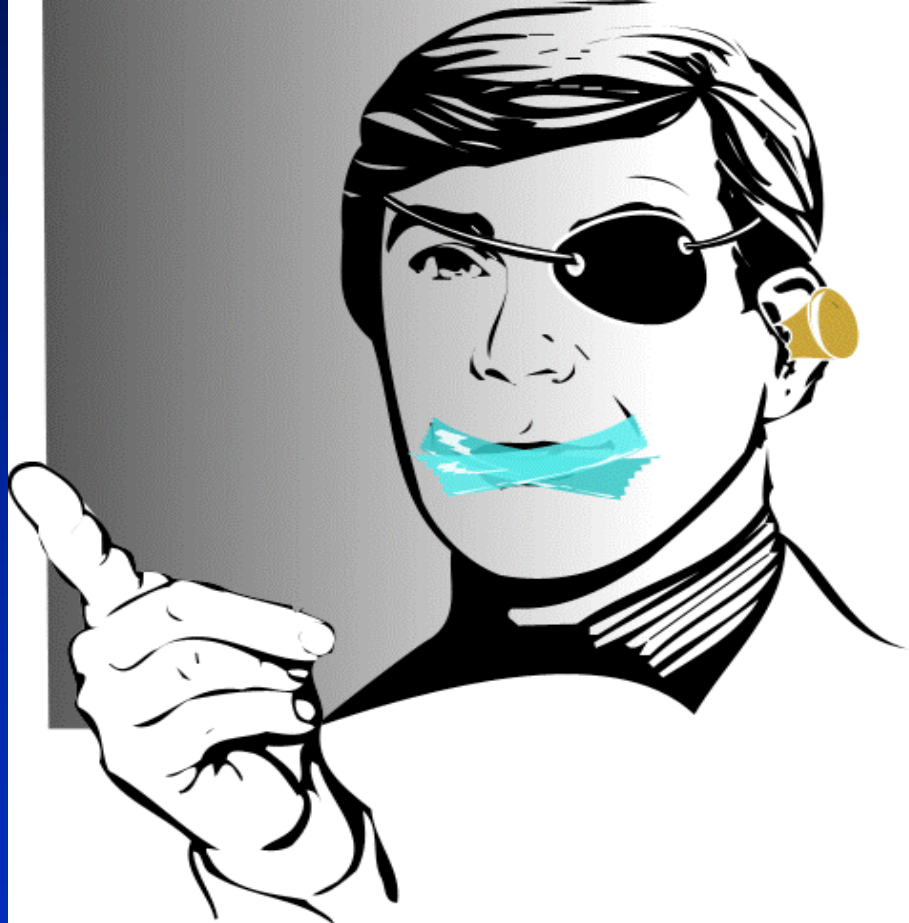
# Impedance-matching our Senses: Limitations of WIMP GUI

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Limited  
Vision  
(Flat, 2D)

No Speech

No Gestures



Limited Audio

One Hand  
Tied Behind  
Back

Limited Tactile

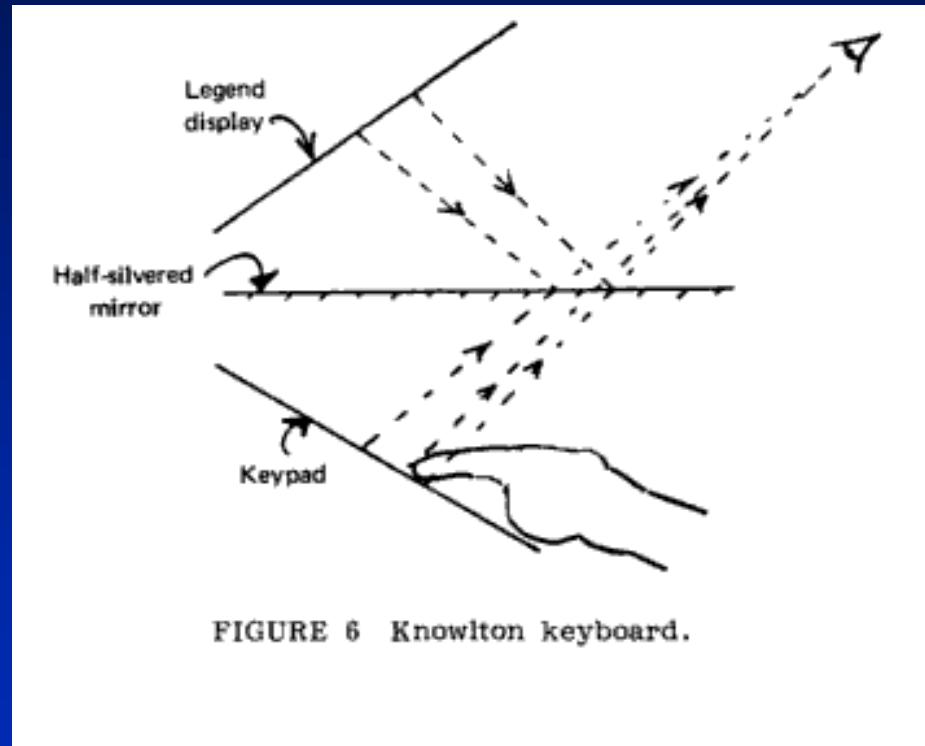
# In the beginning ....: Typing & N-Key Rollover (IBM and others)

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- While it may seem a long way from multi-touch screens, the story of multi-touch starts with keyboards.

# Knowlton keyboard



# Knowlton Keyboard (1966)

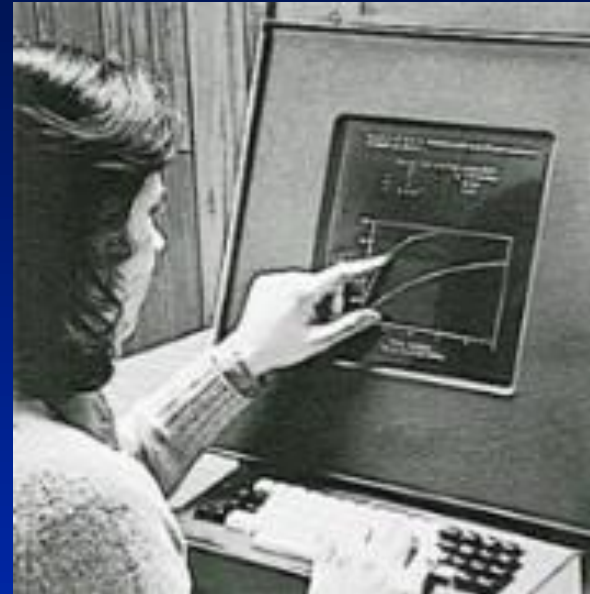
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- Ken Knowlton created a see-through display for Bell labs using a half-silvered mirror, mounted at an angle in front of the telephone operator.
- The image of the keyboard could be superimposed on the operator's hands.
- Keyboard could be dynamically changed.

# 1972: PLATO IV Touch Screen Terminal

(Computer-based Education Research Laboratory, University of Illinois, Urbana-Champaign)

- Touch screens started to be developed in the 1960s.
- Early work was done at IBM, the University of Illinois, and Ottawa Canada.
- All were single-touch and none were pressure-sensitive
- One of the first was the **PLATO IV** computer assisted education system, 1972.
- This plasma display was a precursor to the infrared technology still available today.
- The initial implementation had a 16 x 16 array of touch-sensitive locations



# Bill Buxton University of Toronto

## 1985: Multi-Touch Tablet

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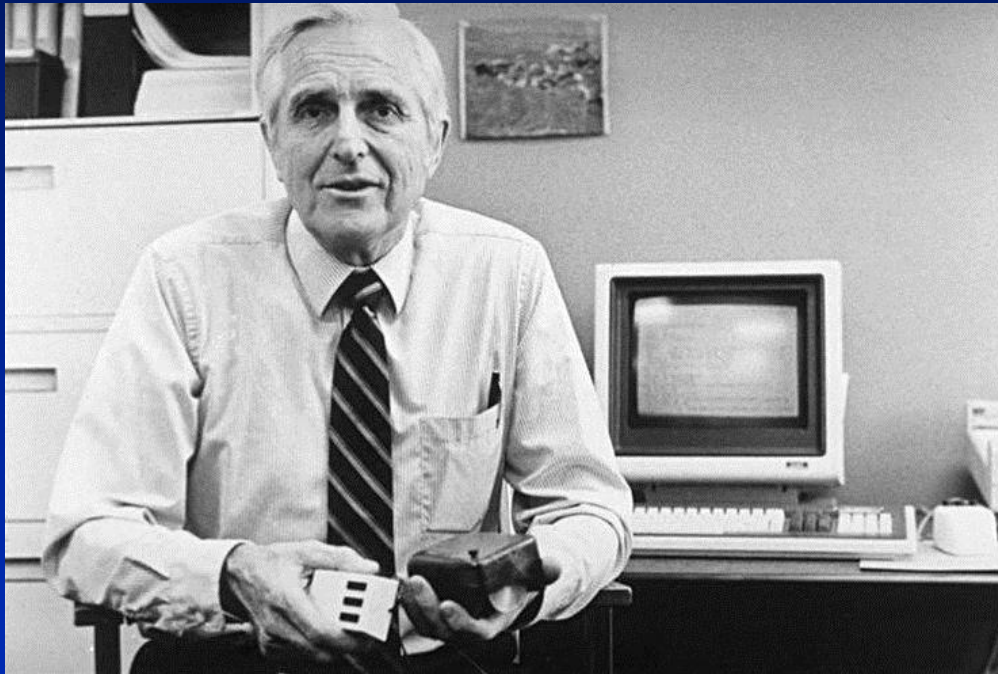
- A touch tablet capable of sensing an arbitrary number of simultaneous touch inputs, reporting both location and degree of touch for each.
- This work was done in 1984, the same year the first Macintosh computer was introduced.
- Used capacitance, rather than optical sensing and thus was thinner and much simpler than camera-based systems.



# Dr. Douglas C. Engelbart

## Computer mouse (1985)

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The first computer mouse held by Engelbart showing the wheels that directly contact the working surface.



# Crossing the Chasm

## Time from Concept to Mass Adoption



1965

First Computer Mouse

1982



1995

Contemporary Computer Mouse



1982

Multi-touch Tablet

2008



iPhone

# Touch Panel Displays

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- The ability to display dynamic color images on a flat, rigid surface has enabled new modes of interaction – Touch Panel Displays
- The most popular are:
  - Resistive systems
  - Capacitive systems
  - Infra-red optical systems
  - Frustrated total internal reflections
- There are many others such as:
  - Surface acoustic waves
  - Strain gauges
  - Thermal
  - Etc.

# Resistive Systems

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- Two thin metallic electrically conductive and resistive layers separated by a thin space
- A scratch-resistant layer is placed on top
- An electric current runs through the two layers when the monitor is operational
- When the user touches the screen, the two layers make contact causing a change in the field and coordinates can be computed
- Transmits only 75% of light from the monitor

# Capacitive Systems

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- In the capacitive system, a layer that stores electrical charge is placed on the glass panel of the monitor
- When the user touches the monitor with his/her finger, some of the charge is transferred to the user
- The decrease is measured by circuits located at the corners of the display and the coordinate of the touch event are calculated
- Advantage – Transmits 90% of light from the monitor

# Apple's iPhone

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- Uses a capacitive technology on an LCD manufactured by Balda (a German company)
- Users tap soft buttons on this display
- Eliminates the WIMP interface (Windows, Icons, Menus, Pointing)
- Uses accelerometers, similar to Nintendo's Wii game console interface
- Everything else is standard

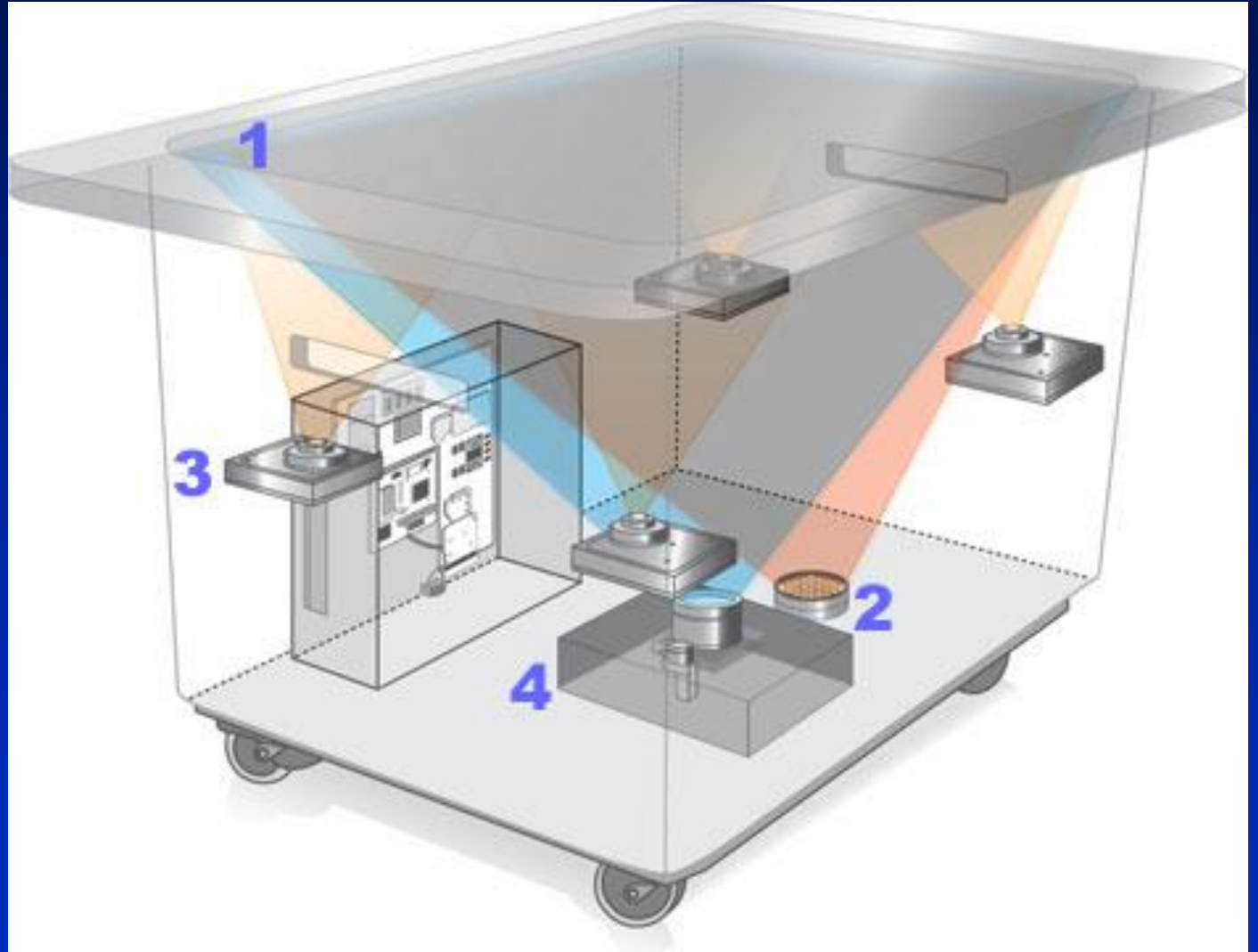
# Infra-red optical systems

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- Surface is bathed with near infra-red light at 850 nanometers so that it is not visible to the human eye
- When an object touches the table top, light is reflected to multiple infra-red cameras with a net resolution of 1280 x 960 allowing it to sense and react to items touching the table top

# Microsoft Surface: Behind the Scenes

1. Screen
2. Infrared
3. CPU
4. Projector



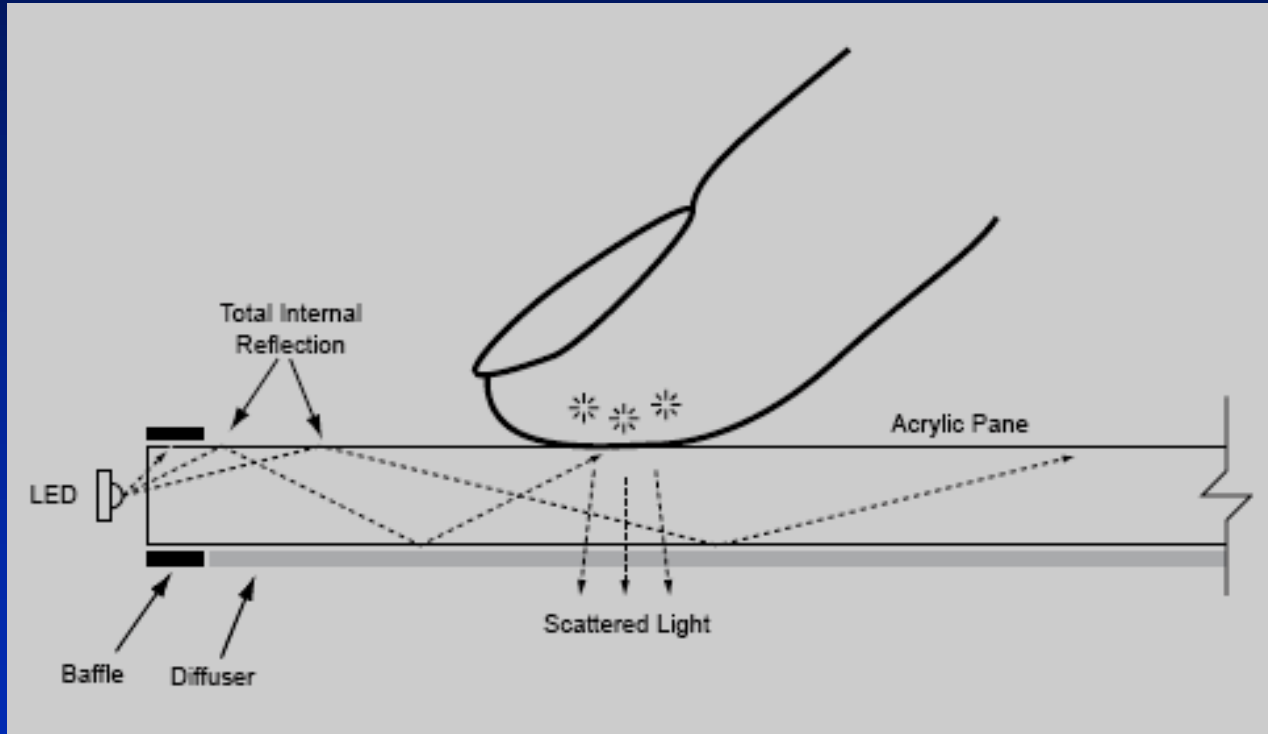


# Frustrated Internal Reflections

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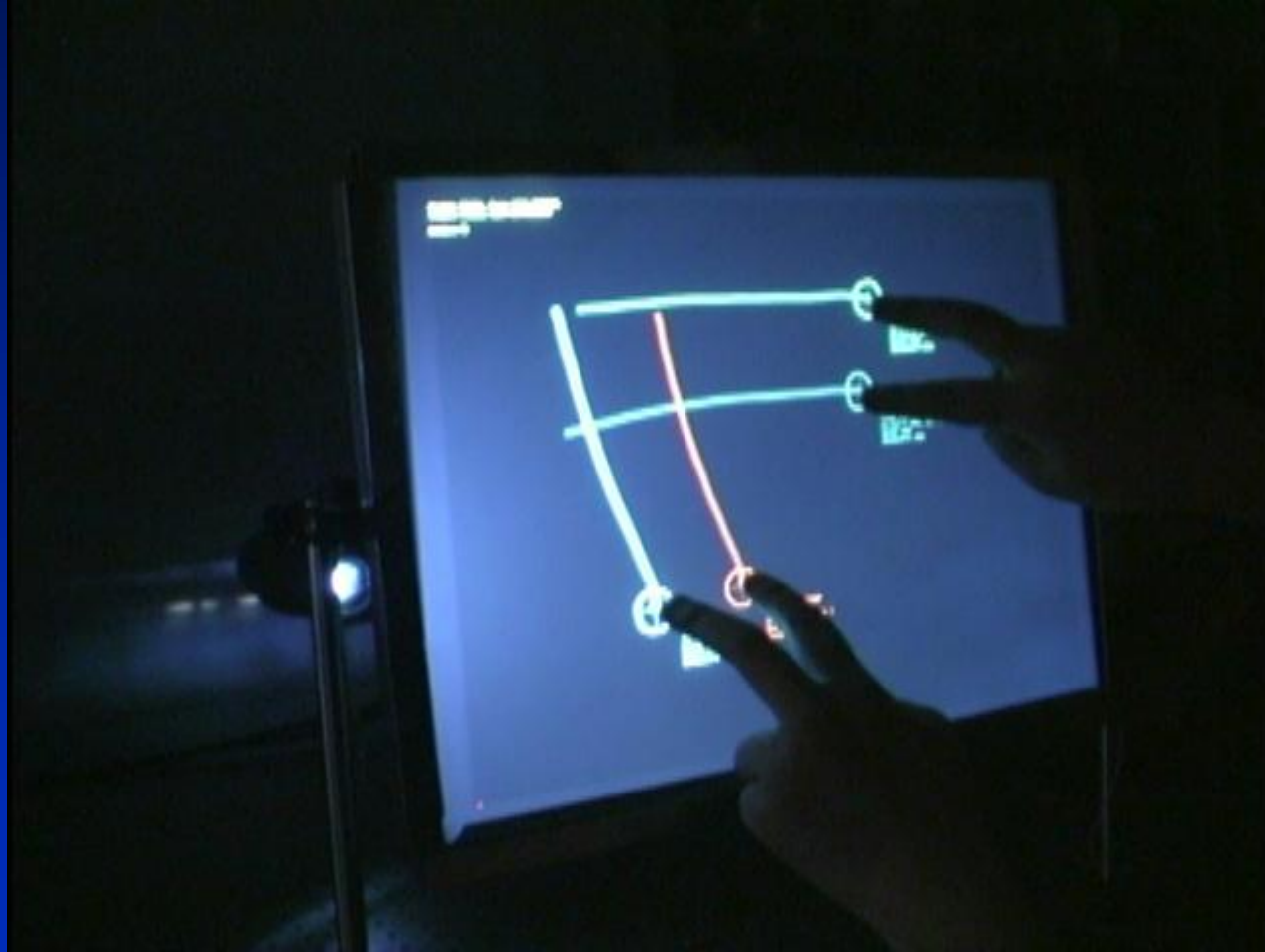
- Light from an LED is sent through the acrylic pane so that there is total internal reflection (Snell's Law)
- When a finger touches the surface, it scatters the light and the location is detected
- Advantages are high spatial and temporal resolutions and the technology is scalable to very large installations
- Multi-touch capability

# Multi- Touch Sensing through Frustrated Total Internal Reflection



# Multi- Touch Sensing through Frustrated Total Internal Reflection

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# Touch - sensing

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**Can touch sensing be more than contact and position?**

- Degree of touch/pressure sensitivity (can possibly get more bits)
- Angle of approach
  - the finger becomes a virtual joystick
  - specifying a vector in the virtual 3D space

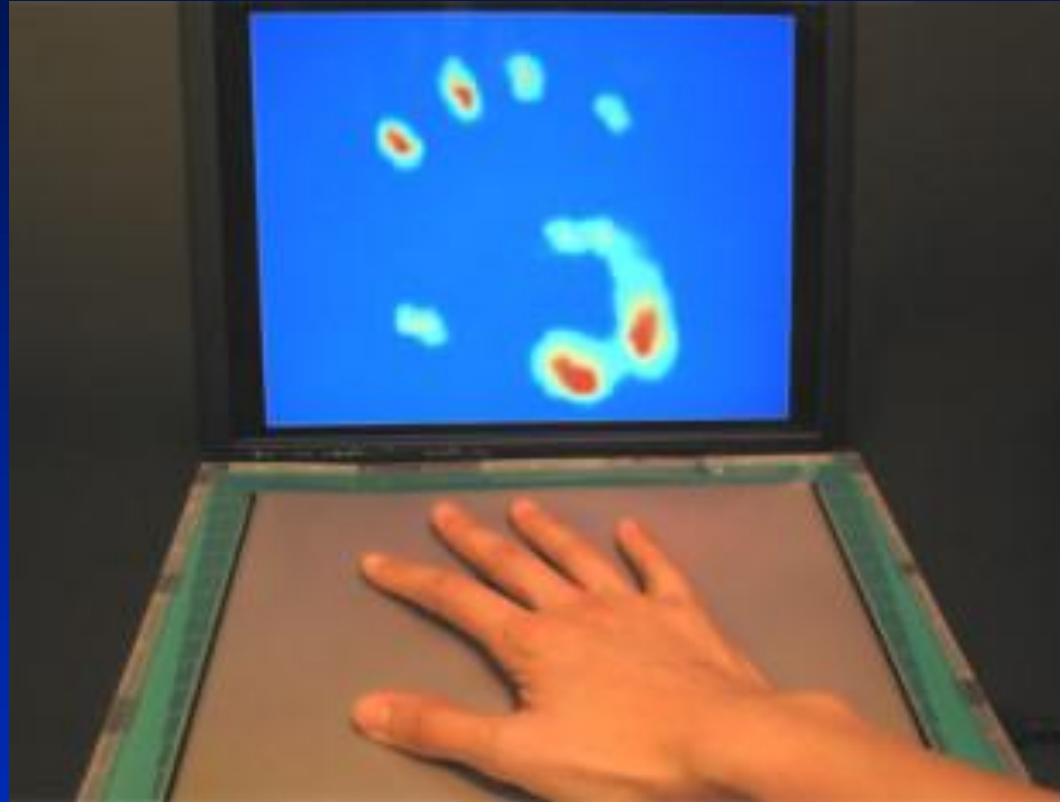
# Touch - sensing

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- Force vectors
  - Can apply a force in any direction parallel to the screen surface
- Gestures
  - Can detect motion paths which can be interpreted (e.g. rotate, throw-away, etc.)
- Stylus and/or finger
  - Gestures versus accuracy
  - Note the Palm Pilot uses both

# Touchco (2009)

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IFSR (Interpolating Force-Sensitive Resistance)

Multi-Touch Sensor Technology

# Transparent Pressure Sensitive Layer

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# Technology Comparison

Capacitive Sensing	Resistive Sensing
▪Position accurate	▪More accurate positioning ▪More data acquisition (force)
▪Greater Cost	▪Low Cost ▪Capability for larger displays
▪More reliable, robust ▪Functions well in all environments	▪Requires more electronics
▪Fast scan rate	▪Slower scan rate
▪Better sensitivity ▪Single user	▪Flexible Input (stylus, etc.) ▪Multiple user
▪More Power	▪Less Power

# Force Sensitive Touch

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- Force Sensitive Resistors
  - Change in force leads to a change in conductive current
  - Current varies according to the amount of contact between two layers
  - Current level goes through analog-to-digital conversion to read out force data

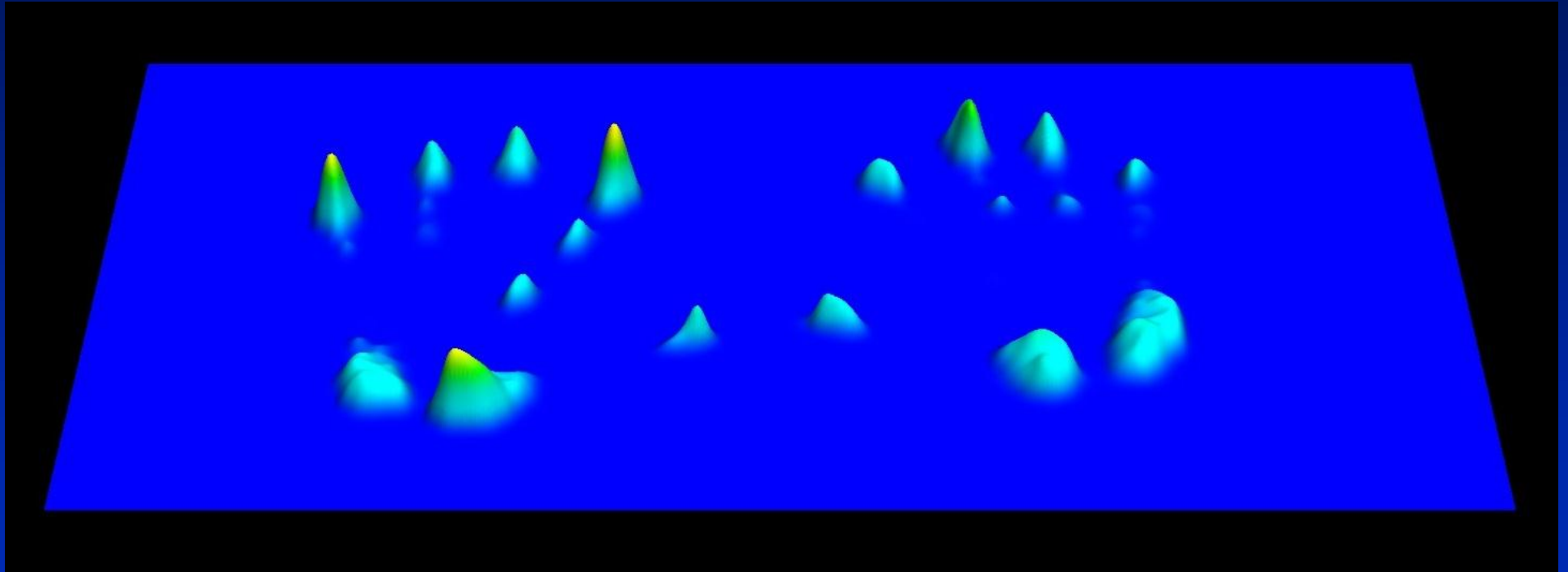


Force  
Applied



# Force Sensitive Touch

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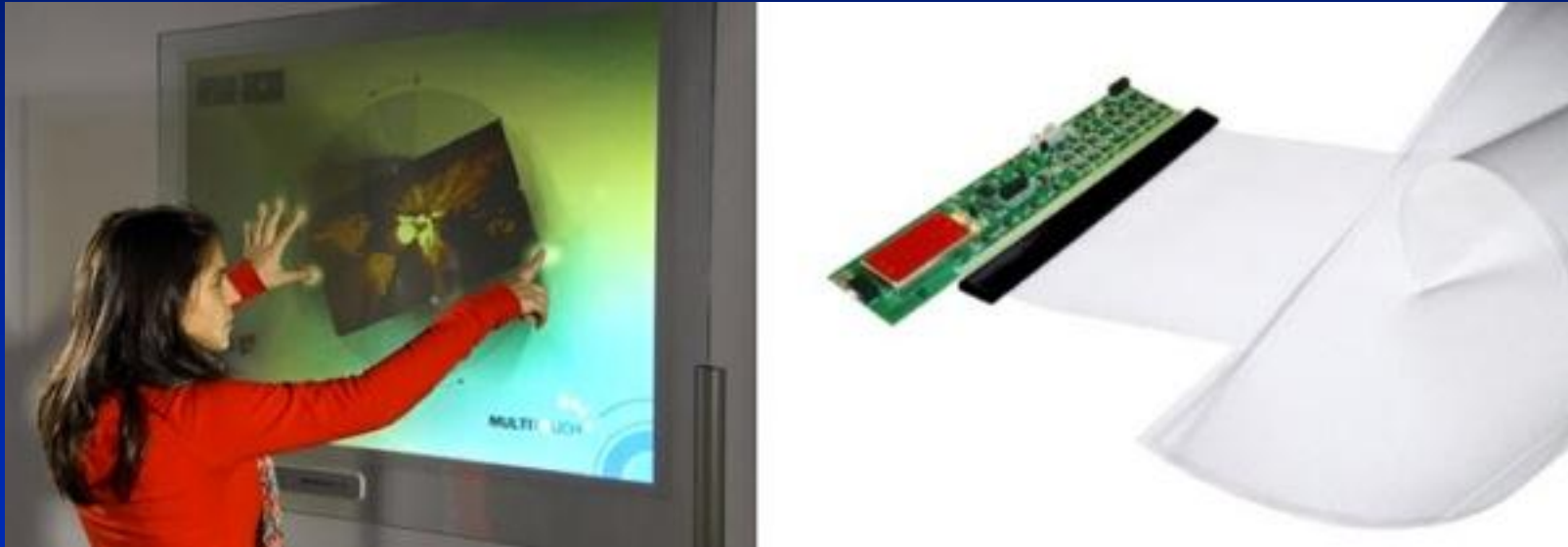
# Multi-Touch Wall

- Large-scale display for multi-user handling



# Multitouch Future: Stick-on Plastic Film

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# Cornell SketchPad

2002

