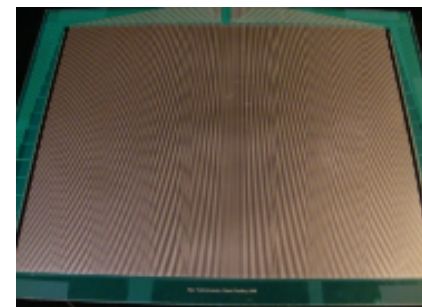




## The methods we were using to approach our past research

- Distinguish between the two different kind of controls
  - Pressure threshold
- Combining Isometric and Isotonic Control to be available at the same time (Using the Pressure-Sensitive UnMousePad)
- Widgets
- GUI navigation
- Degree of freedom control
- Applications design





The earliest investigation of pressure-sensitive touch devices can be back to 1980s when Buxton proposed several interactions for using a pressure-sensitive multi-touch tablet.

## Pressure-Sensitive Inputs

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- Buxton (1985) Multi-Touch Tablet that used capacitance, rather than optical sensing
  - Using pressure for signaling vs. multiple keys of mouse control (SHIFT + X)
  - Continuous pressure sensing with multiple levels of pressure
- Multi-user interaction touch table – Diamond Touch (2001); SmartSkin (2002).
- Ramos research of human ability on selection tasks by varying pressure with gestures
  - The optimal discrete level of pressure using a pen is six.
  - Widgets design: Visual feedback ; Mapping function; Minimize gestures changes
- Davidson using a Perceptive Pixel multi-touch wall (2006)
  - Simultaneously using an isometric tilting with isotonic movement
  - Using pressure to alter the depth of the object
- Rosenberg (2009) The UnMousePad: pressure-sensitive touch input pad
  - Determine accurate pressure data and fine position sensing
  - Detecting subtle finger movements

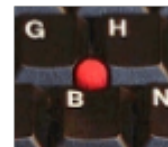


**The IBM joystick developed by Ted Selker first applied the Isometric movement to control the cursor movement.**

## **Isometric and Isotonic**

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- Isotonic gestures requires movements while Isometric's does not
- Zhai - Ability of humans to perform six-degree-of-freedom control
  - Visual feedback
  - Combine isotonic and isometric controls
- Ted Selker – Pointing stick (1984) which becomes IBM track point in the future
  - Uses isometric forces of a finger to move a cursor





**The pressure-sensitive multi-touch device enables the separation and combined using of both isometric and isotonic control.**

## Separating Gestures

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- Isotonic
  - Movement
  - Better at positioning and lower pressure values
- Isometric
  - No movement
  - Better at control the rate (speed-up and slow down while maintaining a level of control) and higher pressure values
  - Faster human response
- Control by Different Muscle groups
- Using a pressure threshold

## Six Degree of Freedom

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- One Possibility
  - Movement X -> Position X
  - Movement Y -> Position Y
  - Scaling -> Position Z
  - Rotation -> Rotation Z
  - Lean X
  - Lean Y

## Isometric Gestures

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- Isometric Click
- One Possible Mapping
  - One touch
  - Multi-touch
  - Hand
- Isometric Twist
- Isometric Pinch



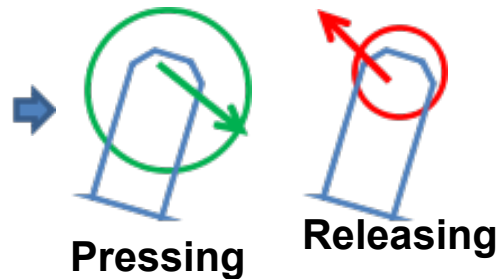
Each isometric interaction requires manipulating the direction, magnitude and distribution of pressure applied to the surface.

## Isometric Click

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Change pressure at one fixed position by pressing and releasing

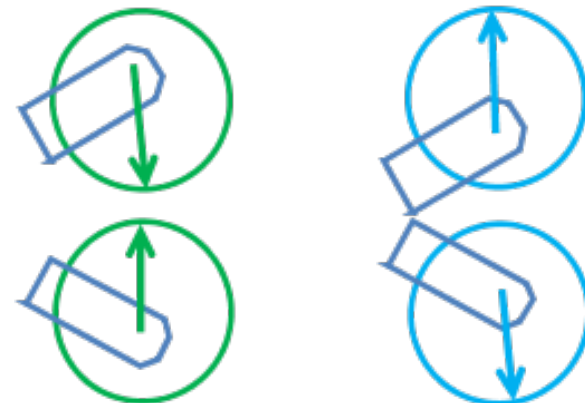
Isotonic double taps for clicking



## Isometric Pinch

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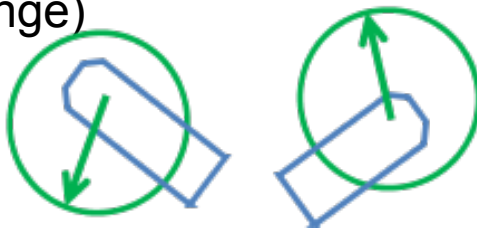
Push two fingers towards or away from each other (force centroids become closer or further)



## Isometric Twist

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Push two fingers clockwise or around a central point (centroids angles change)



Pushing towards

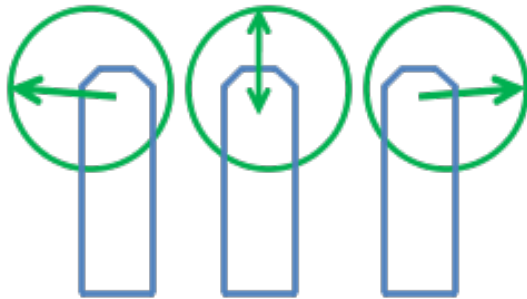
Pushing away



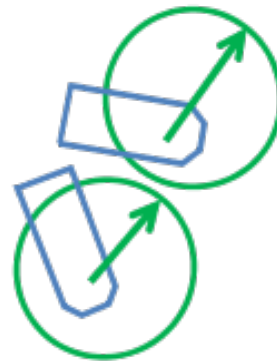
**Leaning, which is one of the basic types of isometric control, can be done by one finger, multi-finger, or the whole hand**

## Isometric Roll/Lean

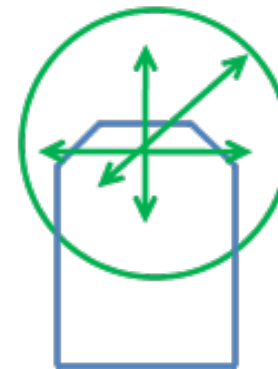
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**One Finger Rolling**



**Two Finger leaning: Pushing towards the same direction**



**Hand Click or Lean**

- One finger leaning direction is evaluated by the changes of the center of mass
- Two finger leaning direction is basing on the force difference, center of mass is calculated by take the weighted average of two fingers
- Hand clicking or leaning is controlled by the summation and weighted average of all the finger touch forces



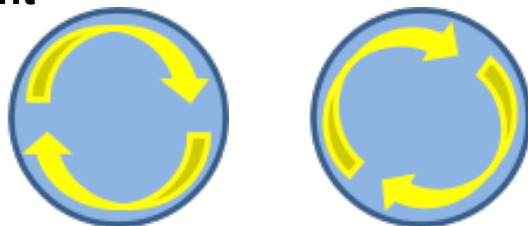
# Designs

By combining isotonic and isometric control on a pressure-sensitive multi-touch device, new interactions that take advantage of these new degrees of freedom become possible in the design of GUI navigation techniques, degree of freedom control, widgets and Applications.

## Widgets to aid the UI design



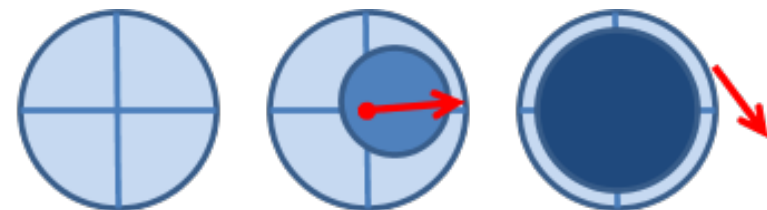
**isometric pressure menu: Lean left or right**



**Isometric twist widget**

## GUI Navigation

- Isotonic and Isometric Rolling Cursor:
  - Positioning: Rolling the finger along x and y directions. (IBM Track point)
  - Selection: Pressing until the pressure pass the threshold



**Cursor position Moving Pressing to select**

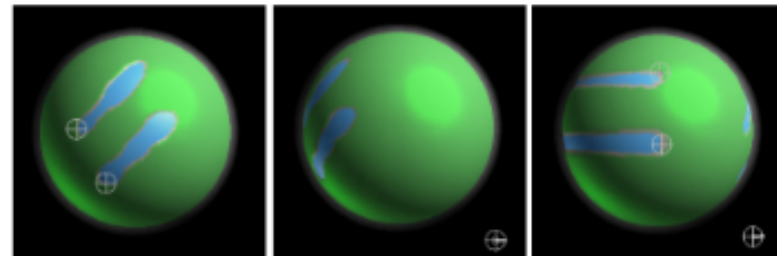


Having both isometric and isotonic control can increase the available degrees of freedom when controlling multiple dimensions of the object and enhance the application design.

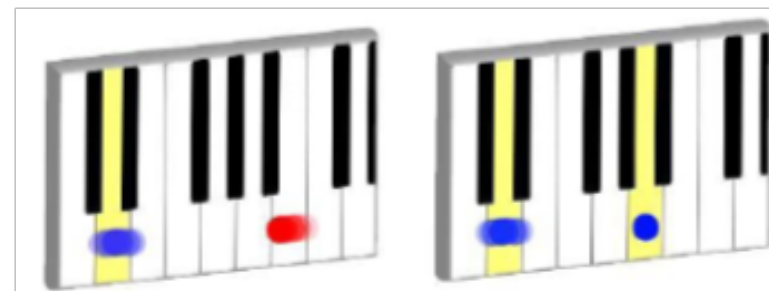
## Degree of Freedom Control

- Isotonic rotate-scale-translate interaction :
  - Size
  - Orientation
  - Location
- Isometric Interaction:
  - Click -> Selection
  - Roll or Lean -> Position
  - Pinch -> Size
  - Twist -> Orientation
- Combining:
  - Isotonic -> individual objects
  - Isometric -> control the world (Control all dimensions in 3D world)

## Applications



**Sculpting (Painting): Isotonic positioning and Isometric for Thickness**



**Piano: key is selected by isotonic position and pressed using an isometric click**





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