The Mouse and Keyboard

Mouse

- A pointing device with one or more buttons
- Important input device, but not required
- User moves physical mouse =>
  - Windows moves a small bitmapped image (mouse cursor) on display
  - "Hot spot" points to a precise location on display
  - Hot spot position constantly updated by low-level logic inside Windows

Mouse Actions

- Button Down, Button Up
- Wheel movement
- Moving mouse
- Clicking
  - Pressing and releasing a mouse button
- Dragging
  - Moving mouse while a button is pressed down
- Double Clicking
  - Clicking a button twice in succession
  - Must occur within a set period of time and with mouse cursor in approximately the same place
    - Form's SystemInformation class has two properties that give this information:
      - int DoubleClickTime
      - Size DoubleClickSize

Information about Mouse

- More of Form's SystemInformation Properties:
  - bool MousePresent
  - int MouseButtons
    - Gets number of mouse button on the mouse
  - bool MouseButtonsSwapped
  - bool MouseWheelPresent

Mouse Events

- The "Control" Class defines 9 mouse events and 9 corresponding protected event handler methods
  - Form class is derived from Control class
- Only one control or form receives mouse events
  - The one that has its Enabled and Visible properties set to true
  - If multiple controls are stacked, the enabled visible control on top receives the event
- A Form object receives mouse events only when mouse is over its client area
  - But mouse can be "captured" by a control -- so it can receive mouse events when mouse is not over it

Some Basic Mouse Events and Handler Methods

- MouseDown OnMouseDown( )
- MouseUp On MouseUp( )
- MouseMove OnMouseMove( )
- MouseWheel On MouseWheel( )
  - Delegate for each event: MouseEventHandler
  - 2nd argument for each handler: MouseEventArgs
- Click OnClick( )
- DoubleClick OnDoubleClick( )
  - Delegate for each event: EventHandler
  - 2nd argument for each handler: EventArgs

MouseEventArgs Property

- Gives access to read-only properties that come with mouse events
  - int X Horizontal position of mouse
  - int Y Vertical position of mouse
  - MouseButtons Button
    - MouseButtons enumeration possibilities:
      - None, Left, Right, Middle
        - » e.g., MouseButtons.Left
      - Indicates which button or buttons are currently pressed
      - Each button corresponds to a bit set

Click/DoubleClick EventArgs Static Properties

- Give access to static, read-only properties that come with mouse Click and DoubleClick events
  - Point MousePosition
    - Result in screen coordinates
    - To convert to client area coordinates, use PointToClient( )
  - MouseButtons MouseButtons
    - Returns which buttons are currently pressed

Sketching Example Program

- Sketch-dotNet
  - Sketching revisited
    - Using C# and the .NET Framework Class Library
- But if window is exposed, the sketch disappears
- Two ways to avoid this:
  1. Save the points in each sketch and redraw all line segments in response to Paint event
  2. Draw the sketch on a shadow bitmap that the program draws on while it's drawing on the screen
     - Then redraw the bitmap in response to Paint event

Saving the Sketch points

- Could use an array:
  - Point[ ] apts = new Point[?????]
    - But how big?
- Better to use a C# dynamic "ArrayList"
  - A class defined in System.Collections namespace
    - Also has data structures like: Queue, Stack, SortedList, HashTable
  - To create a new ArrayList:
    - ArrayList arrlst = new ArrayList( );
      - Could hold any data type(s)
  - To add elements, e.g., a Point p:
    - arrlst.Add(p);
    - Can also Insert( ) and Remove( ) elements
  - Accessing an element: use an indexer as for an ordinary array
    - Point p = (Point) arrlst[2];
    - Note typecast
      - Needed because indexer returns an object of type Object
  - Number of objects in an Arraylist: arrlst.Count

New Sketch-dotNet using an ArrayList

- A single run can have many sketches
  - One for each time left mouse button goes down
  - So use one ArrayList to store the points for each sketch
    - When finished (when mouse button goes up), convert to an array of Points
  - Use a second ArrayList to store the array of points for each sketch (i.e., an ArrayList of sketches)
- MouseDown event ✍ start a new sketch's ArrayList
- MouseMove event ✍ draw line segment and add the point to current sketch's ArrayList
- MouseUp event ✍ convert current ArrayList of points to an array of points & it to the ArrayList of sketches
- Paint event ✍ use DrawLines(…) to draw all the line segments in each ArrayList

  g.DrawLines(Pen pen, Point[ ] a_pts); // a_pts is an array of Points
- See Sketch-dotNet-ArrayList example program
  - Here we're really storing the drawing in a Metafile format

New Sketch-dotNet using a Shadow Bitmap

- Store the window client area as a shadow bitmap
  - Draw on the shadow bitmap and on screen when mouse moves with its left button down
  - Draw the shadow bitmap on the the screen when a Paint event occurs
  - Note that with this technique all of the information on the original points is lost
- See the Sketch-dotNet-Bitmap example program

Some Other Mouse Events and Event Handlers

- MouseEnter OnMouseEnter( )
  - Mouse cursor has been moved onto form's client area
- MouseLeave OnMouseLeave( )
  - Mouse cursor is no longer on top of client area
- MouseHover OnMouseHover( )
  - Mouse cursor has entered client area and has stopped moving
  - Only happens once between MouseEnter and MouseLeave events
- Delegate for each: EventHandler
- Argument for each: EventArgs
- See Mouse-Enter-Leave-Hover example program

The Mouse Cursor

- A little bitmap on screen that indicates the location of the mouse
- Can change its appearance
- It's an object of type 'Cursor' defined in System.Windows.Forms
- Get a mouse cursor from the 'Cursors' class
  - Consists of 28 static read-only properties that return predefined objects of type 'Cursor', e.g.:
    - Arrow, Cross, Default, Hand, Help, Ibeam, WaitCursor, etc.
- Some Static read/write Properties of 'Cursor' class:
  - Cursor Current
  - Point Position
  - For example to display the hourglass cursor on the form:
    - Cursor.Current = Cursors.WaitCursor;
- Some Static Cursor methods:
  - Show( ); Hide( );
- See MouseCursors example program

The Keyboard

- A shared resource in Windows
  - All applications receive input from same keyboard
  - But any keystroke has a single destination
    - The destination is always a 'Control' (e.g. a Form)
  - Object that receives a keyboard event has the "input focus" – the active Form
    - Usually the topmost form
    - If form has a caption bar, it is highlighted
  - Form.ActiveForm static property returns the active form
  - this.Activate() method can be used to make this form the active form

Keys and Characters

- Think of keyboard in two ways:
  - A collection of distinct physical keys
    - Code generated by a key press or release identifies the key
  - A means of generating character codes
    - Code generated identifies a character in a character set
      - Traditionally 8-bit ASCII code
      - In Windows, extended to 16-bit Unicode
      - Keyboard combinations (Shift, etc.) taken into account

Types of Keys

- Keyboard divided into four general groups of keys
  - Toggle keys: Pressing key changes state
    - Caps Lock, Num Lock, Scroll Lock, Insert
  - Modifier keys: Pressing key affects interpretation of other keys
    - Shift, Ctrl, Alt
  - Non-character keys: Not associated with displayable characters; direct a program to carry out certain actions
    - Function keys, PgUp, PgDn, Home, End, Insert, Delete, Arrow keys
  - Character keys: Letters, numbers, symbol keys, spacebar, Backspace, Tab key
    - Generate ASCII/Unicode codes when pressed

Keyboard Events & Data

- KeyDown, KeyEventArgs
  - When a key is pressed (WM_KEYDOWN)
- KeyPress, KeyPressEventArgs
  - When a character-generating key is pressed (WM_CHAR)
  - Occurs after a KeyDown event
- KeyUp, KeyEventArgs
  - When a key is released (WM_KEYUP)
- Note KeyUp/KeyDown and KeyPress event data is different
  - KeyUp/KeyDown events provide low-level information about the keystroke – which key
  - KeyPress provides the character code
    - Keyboard combinations taken care of

KeyDown/KeyUp Events

- KeyEventArgs Properties
  - KeyCode Identifies which key
  - Modifiers Identifies shift states
  - KeyData Combines KeyCode & Modifiers
    - Keys: a huge enumeration, some examples:
      - Keys.A, Keys.z, Keys.D0 (zero key), Keys.F1, Keys.Add, Keys.Home, Keys.Left, Keys.Back, Keys.Space, Keys.LShiftKey
      - See Online Help on "Keys enumeration"
  - bool Shift True if Shift key is pressed
  - bool Alt True if Alt key is pressed
  - bool Handled Set by event handler (initially false)
  - int KeyValue Returns KeyData as an integer

KeyPress Event

- When key(s) pressed correspond to character codes
- KeyPressEventArgs Properties:
  - char KeyChar Unicode/ASCII character code
  - bool Handled Set by handler (initially false)

Two Example Programs

- Key:
  - Assembles incoming characters from keyboard into a string that is displayed on the form's client area
    - Handles Backspace key by removing last character from string
  - Handles KeyPress event
- KeyArrow:
  - Moves an image on the form's client area in response to keyboard Left/Right/Up/Down arrow key presses
  - Handles KeyDown event