

The Tablet PC: Designing Pen- based Applications

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Who am I?

- Developer Lead, Tablet PC End-user team
- Co-author of *Building Tablet PC Applications* from MS Press
- Working on the Tablet PC since August 2000
 - Ink usage model (real-time ink, ink interaction)
 - "Making the pen great"

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Topics

- Tablet PC introduction
 - What and why
- Usability issues
 - Hardware requirements
 - Display
 - Pen as mouse
 - Digital ink entry, editing, gestures, and recognition

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What's a Tablet PC?

- Pen-driven computer with various form-factors
 - Pure slate
 - Convertible
- It's a full PC
 - Fast processor, lots of memory, hard-drive, high-resolution graphics
 - Runs Windows applications
 - "Laptop with a pen"

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Why Tablet PC?

- Desktop and laptop computing doesn't fit well with certain common situations
 - Meetings: laptops can be annoying and/or remove user from discussion
 - Relaxing (e.g. leaning back in chair, lying on couch): laptops must be on a flat surface
 - On-the-go (walking, standing waiting): laptops must remain statically positioned for use

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Why Tablet PC?

- Desktop and laptop computing can feel unnatural
 - Entering information can be awkward (e.g. ASCII text into a word-processor)
 - Using the mouse – hard to master, and disconnected from the task at hand
 - Must be sitting upright when operating a computer

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Why Tablet PC?

- Using a pen is natural
 - Task adapted to human physiology rather than the other way around
 - Evolved over thousands of years
- Easy
 - Most people can do it
 - Direct interaction/input
 - "Always on"

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Why Tablet PC?

- Ink is a great data type
 - Expressive
 - Text, graphics, diagrams, etc.
 - Personal
 - ASCII text is "cold" :-)
 - Free-form input
 - Write anywhere

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Why Tablet PC?

- Hardware finally makes it doable
 - Small enough: 8.5" x 11", under 3 lbs, less than 1" thick, good battery life
 - Cheap enough: shouldn't cost more than a nice laptop
 - Fast enough: real-time ink, handwriting recognition
- Software is good enough
 - Handwriting recognition doesn't suck
 - "Ink as ink"

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Why past efforts failed

- Hardware was cumbersome
 - Units were slow and heavy
 - Screens were black and white, low resolution
- Handwriting reco was bad, but the usage paradigm needed it to be great
 - Often, ink was instantly converted to text, making bad reco obvious
- Usage paradigm was unnatural
 - Conversion to text often required
 - Little use of free-form input
 - Ink "gestures"

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Why past efforts failed

- No standard software development platform
 - Low market penetration, tough business justification for 3rd parties
 - Therefore no "killer apps"
- Portable computers were niche
 - Networking wasn't common for PCs
- Tradeoffs were significant in comparison to today (e.g. screens, upgradability, speed)

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What about palm-sized devices?

- Great at what they do
 - Contacts, scheduling, jotting down short notes, etc.
 - Saving grace (IMO): synchronization with desktop PCs
- Form factor is awesome
 - Fits in your pocket or hand!

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What about palm-sized devices?

- We still have to adapt to them
 - Small screens
 - "Graffiti" input
- Not good at desktop tasks
 - Unsatisfying for web surfing, email composition, document viewing, etc.
 - Syncing is a pain for some
 - Peripheral device for many users

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Windows XP Tablet PC Edition

- Version 1.0 released November '02
- Superset of Windows XP Professional
 - Runs all apps XP Pro can
- Culmination of many years of work
 - Ink recognition software
 - End-user studies
 - Learning from the past
- Evolution rather than revolution

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Windows XP Tablet PC Edition

- The goal: the simplicity of paper combined with the power of the PC
 - "Ink as ink" / "Ink as a first-class type"
 - Data lives life as ink
 - Editable, searchable, persistable
 - Natural feel
 - Ink flows out of the pen quickly and smoothly
 - Free-form input
 - Pages of paper instead of infinite canvas

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Windows XP Tablet PC Edition

- The goal: the simplicity of paper combined with the power of the PC (cont'd)
 - Using existing ("legacy") apps with the pen
 - Mouse input
 - ASCII text input

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About the digitizer

- Want accurate ink: looks more "real", and has better recognition results
 - Therefore need high sampling rate with high resolution
- Must be low power consumption
 - Narrows range of technologies that can be employed
- Electromagnetic is popular choice, but not without tradeoffs

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About the digitizer

- Pen hovering capability
 - Important to connect the user interface with the pen even when it's not touching the screen
- Capture other data from pen besides x,y position
 - Pressure, tilt, rotation, roll, etc.
 - Great ink and data manipulation

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About the digitizer

- Tradeoffs: sensitive to interference
 - Hard drive, CPU, battery, and other components can alter where the digitizer thinks the pen actually is
 - Calibration system (i.e. software correction) helps tremendously, but still not perfect

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Display hardware

- User can't write directly on the LCD surface
 - Psychedelic color blooming occurs because of squishing liquid crystals; very distracting
 - Bad for the display
- Solution: glass overlay
 - Doesn't allow any "give" across the display
 - Protects the LCD

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Display hardware

- Tradeoffs:
 - No "give" means it feels unnatural
 - Glass is slippery to a hard plastic pen
 - Pen skids a little, making writing and targeting a bit more difficult
 - Parallax
 - Thickness of glass causes visual disconnect from ink/cursor/etc. when pen tip touches the display
- These will get better

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Pen/stylus design

- Very personal piece of hardware!
 - People play with it, chew on it, etc.
- Should be as close to a ballpoint in size and weight as possible
 - Pocket clip is a good thing too, even if people don't use it for their pocket
- Needs rugged design
 - Most people on the tablet team have broken a pen because the design was fragile

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Pen/stylus design

- Pen tip
 - Some pens have their tip act as a momentary switch so the digitizer knows when the pen is touching vs. hovering - feels strange
- Pen button
 - Very useful trigger for non-ink functionality
 - Right-button click, erasing, selection, etc.
 - Some designs are very prone to accidental clicks by users
 - Causes undesirable behavior - very frustrating!

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High DPI displays

- Displays are small but high resolution - increased DPI
 - Ink and eBooks look great
- Tradeoff: Legacy apps suffer
 - Many hard-coded pixel sizes, meaning text, icons hard to see
 - Targeting areas get smaller
 - Can only expect evolution here; platform makes this a pain today, tomorrow will be easier

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Writing for high DPI

- To write high-DPI-capable applications:
 - Make controls and tolerances device-independent
 - Don't make assumptions about the DPI
 - Avoid things that don't scale well

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Testing for high DPI

- Don't need High DPI Hardware
 - Control Panel -> Display -> Settings -> Advanced
 - On the General tab, in the Font Size box, change your System DPI
- What to Check:
 - Text and images that are too small
 - Images that are properly sized, but are of poor quality because of scaling
 - Lines that are too thin to see easily (At higher DPI, a one-pixel-wide line is nearly invisible)
- Test at 96 and 120

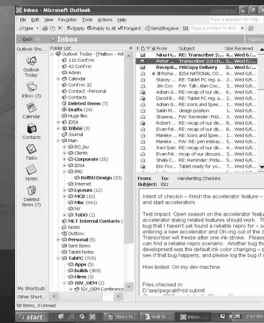
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Portrait-mode display

- Support portrait mode; just like paper
 - Great for web surfing, reading eBooks and most other document types
 - Hot-switch to landscape and back is great for convertibles
- Tradeoff: Legacy apps suffer
 - All written assuming horizontal > vertical resolution
 - Toolbars, menus, etc. can be cut off

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Portrait orientation



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Pen as mouse: Hovering

- Hovering still with a pen is tough
 - While in-air, our control of a pen is considerably worse than when the pen is touching a surface
 - Mouse is intrinsically static, pen is not
 - Legacy applications typically assume cursor must be perfectly still for e.g. tooltips to appear
 - Software help needed to "smooth" hover location of cursor

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Pen as mouse: Hovering guidelines

- Features requiring hover should have generous tolerances
 - For instance, tooltips
 - Use COMCTL32 provided ToolBars
- Test hover-triggered features for ease of use

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Pen as mouse: Obstruction

- Viewing obstruction
 - Pen is a direct pointing device and the hand covers screen; mouse does not
- Menus and tooltips display towards the right
 - Most people are right-handed!
- Lefties have it tough with scrollbars



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Pen as mouse: Obstruction guidelines

- Ensure state changes do not occur under the hand
- Ensure that consequences of actions do not appear under the hand
- Respect user handedness system setting
 - Check `SPI_GETMENUDROPALIGNMENT` via `SystemParametersInfo()`
 - Apply it to Tooltips, menus, popup menus

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Pen as mouse: Targeting

- Because hovering still with a pen is tough, targeting is tough
 - Operations such as resizing windows, selecting ASCII text, clicking push buttons, checkboxes, scrollbar buttons, etc. were designed for the mouse
 - Downward motion of pen alters x,y location of cursor
 - Very frustrating for users to "miss"
 - Software help would have great benefits

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Pen as mouse: Clicking

- Clicking with a pen is tough
 - Legacy applications typically assume during a click the mouse doesn't move
 - Pen taps are more like little strokes or stabs because of pen skidding and high-precision digitizers
 - Detecting the difference between tap and a drag is an interesting problem!
- Double-clicking is even tougher
 - Quick motion means sloppier result

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Pen as mouse: Pen positioning

- Pen positioning can be arduous work if UI requires targeting all over the display
 - Mouse can move the cursor far without much arm/hand movement, but the pen requires a lot of arm/hand movement
 - Menus and toolbars are typically at the top of a window; editing often occurs mid-way or toward the bottom
 - Lots of physical arm/hand movement results – a real pain for users
 - More local UI is desirable (e.g. context menus)

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Pen as mouse: Targeting guidelines

- Cursor feedback
- Bigger, easily-targeted controls
- Generous tap, double-click, and hover tolerances
- Keep related objects in proximity

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Pen as mouse: Right-clicking

- Need to be able to right-click with the pen
 - While not used by majority of Windows users, still an important capability for backwards compatibility and contextual UI
 - Solutions: "Press-and-hold" and pen barrel-button invocation
 - P & H was fairly controversial because some felt it got in the way

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Digital ink realism

- Ink should look smooth
 - No "jaggies" -> antialiased
 - No straight lines -> curve-fitted
- Use pen pressure information
 - Vary stroke width (more pressure means wider stroke)
- Support pen tips
 - Round/ballpoint vs. rectangular/highlighter

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Digital ink performance

- Writing requires uninterrupted inking
 - Users have difficulty with delays in ink appearance
 - Users are frustrated with delays in inking
- Guideline
 - Ensure fast efficacy
 - Is it as fast as writing on paper?

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Pen modes & cursors

- Explicit vs. implicit input modes
 - A.k.a. *Modal* vs. *modeless*
- How to allow things to be efficient but not confuse users
 - Select mode uses "right-mouse button" for implicit mode as well as utilizing an explicit mode
 - Erase mode uses pen's eraser tip (if available) for implicit mode as well as utilizing an explicit mode

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Pen modes & cursors

- Need feedback as to the mode of the pen
 - Indicates actions available to the user
- Guideline
 - Develop a set of cursor feedback to indicate the different modes of the pen
 - Careful attention to cursor design
 - Either symmetric or use handedness setting

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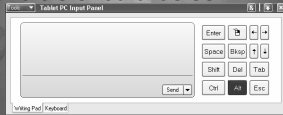
Pen gestures

- Gestures need precise tuning
 - Trade-off between accidental activation vs. not getting when wanted
 - False activations are annoying and distracting to the task!
- Guideline
 - Use gestures guardedly
 - Error on the side of having "zero" incidence of false activation
 - Non-destructive consequences are better

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Writing location

- Users have an initial expectation that they can write digital ink anywhere
- Guideline
 - Communicate clearly where users can ink
 - Ink enabled controls should be self-evident



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Ink selection

- Traditional rectangular selection tools are inadequate
- "Lasso" selection is much more natural
 - Percentage-based stroke tolerances
 - Employ word-based selection
 - Visual feedback is essential, real-time is much better than static

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Recognition expectations

- Handwriting recognition is highly variable by person
 - Errors are expected
 - Perceived good or bad handwriting effects expectation of accuracy
- Guideline
 - Be realistic about recognition accuracy rate, don't rely heavily on it for authoring

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Additional resources

- Tablet PC Platform SDK documentation
- <http://www.tabletpcdeveloper.com>
- Newsgroup: microsoft.public.windows.tabletpc.developer on msnews.microsoft.com
- *Building Tablet PC Applications*, Microsoft Press
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