

EXHIBIT E

AppLens and LaunchTile: Two Designs for One-Handed Thumb Use on Small Devices



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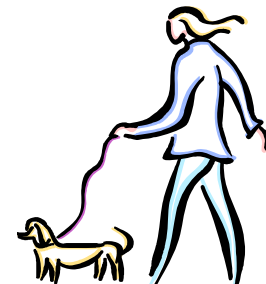
John SanGiovanni

Microsoft Research
Microsoft Corporation



Why One-Handed Interaction?

- One hand occupied



- Unstable environment

- Attention divided among tasks



- Two handed use unnatural

Input and Interaction on Existing Devices

■ Smartphones

- Input: Hardware Buttons
- Interaction: One-handed
Keypad-mapped functions
Directional navigation



■ Personal Digital Assistants (PDAs)

- Input: Touch Sensitive Display
Hardware Buttons
- Interaction: Two-handed
Small software targets
Directional navigation



Design Goal

- Scalable User Interface (ScUI)
 - Single design & interaction architecture
 - Multiple resolutions & aspect ratios
 - University of Maryland's PocketPiccolo.NET toolkit for Zoomable User Interfaces (ZUIs)



iMate Smartphone II

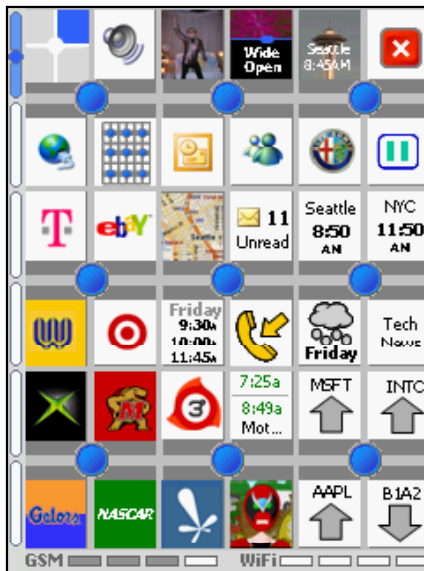
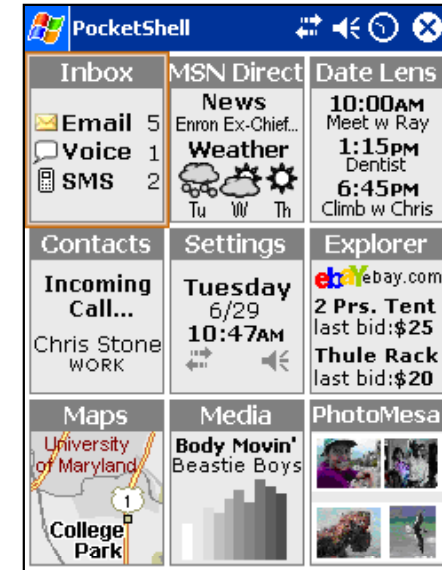


HP iPAQ PocketPC

One Application, Two Designs

AppLens: Fisheye+Pan

- 9 Application Tiles
- Fisheye Zoom
- Command-Based Gestures



LaunchTile: Zoom+Pan

- 36 Application Tiles
- Pure Zoom
- Direct Manipulation Gestures

Related Work

- Gestures using Position & Orientation
 - General Purpose [Reikimoto 1996] [Hinkley 2000]
 - Text Entry [Sazawal 2002] [Widgdor 2003]

- Gestures with Stylus
 - App Specific [Buyukkokten 2000] [Baudisch 2004]
 - Text Entry [Perlin 1998] [Wobbrock 2003]

- Thumb-Based Hardware



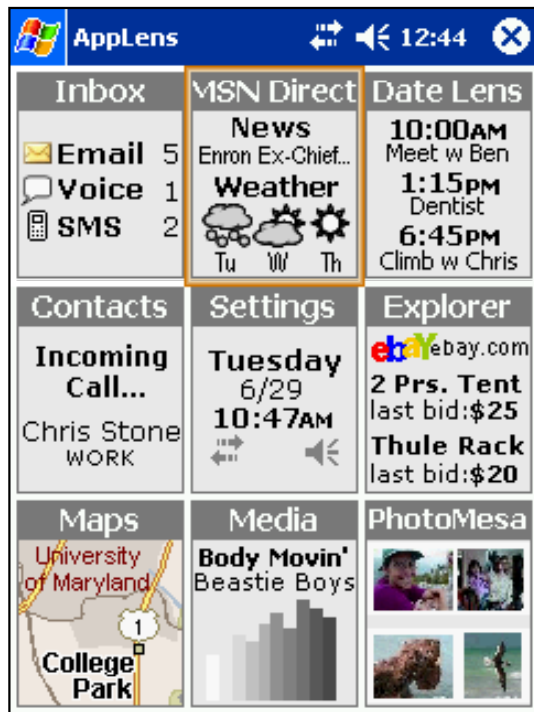
Jackito PDA



Apple iPod

AppLens Visual Design

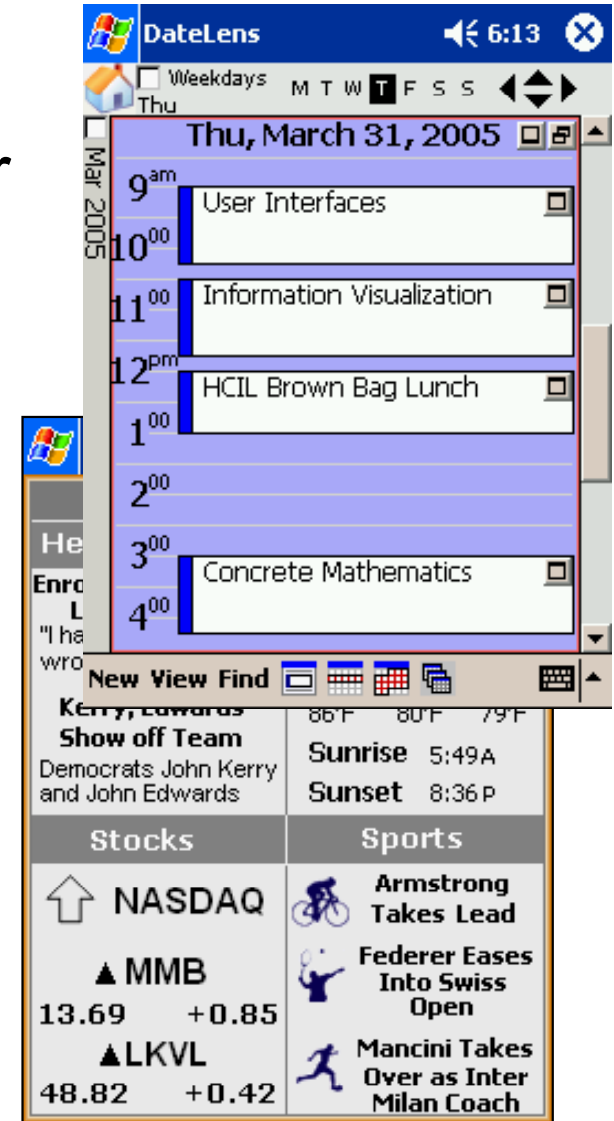
- Generalized tabular fisheye
 - Motivated by DateLens calendar
- Three (fisheye) zoom levels



Notification



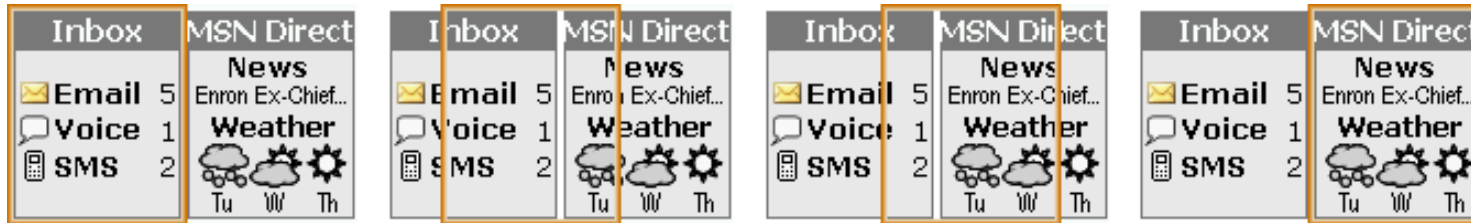
Context



Full

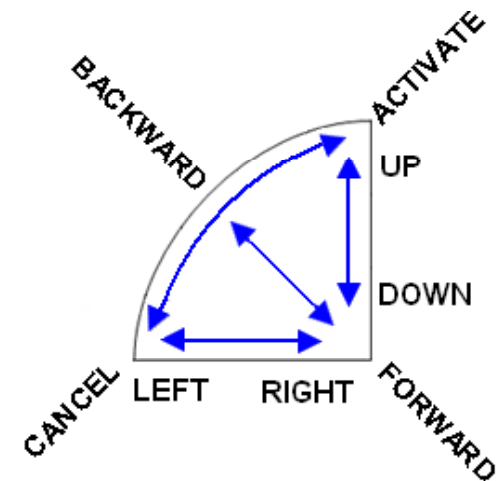
AppLens Interaction Design

- Input cursor



- Command gestures

- Issued anywhere
- Access distant widgets
- Don't interfere with tap

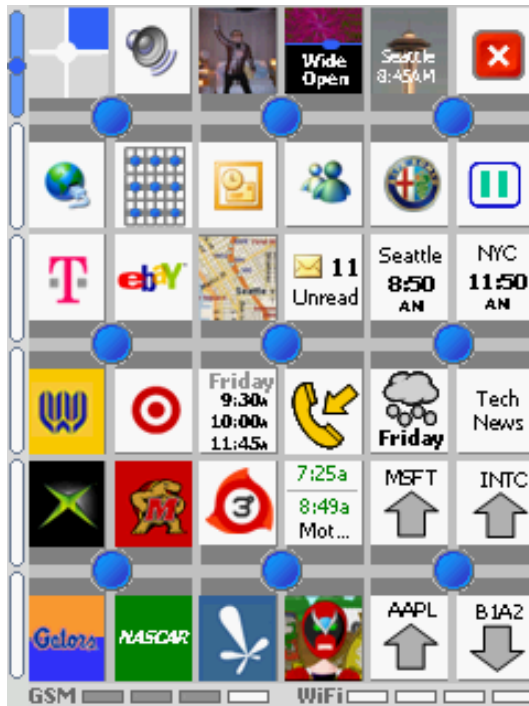


AppLens Video

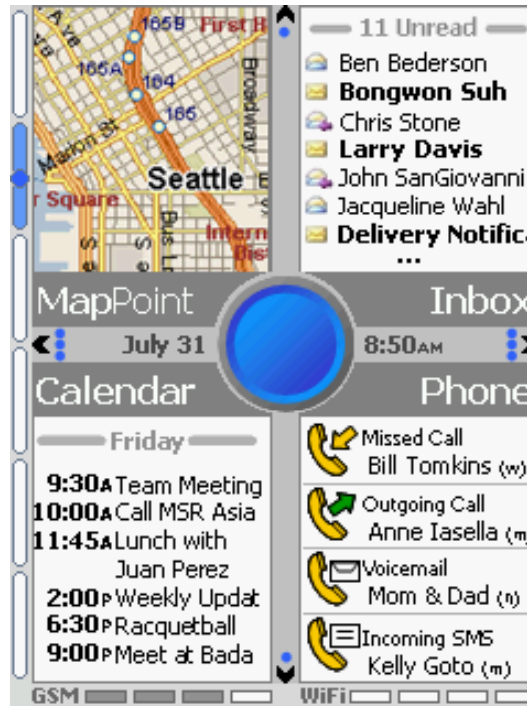
Interactive prototype based on images

LaunchTile Visual Design

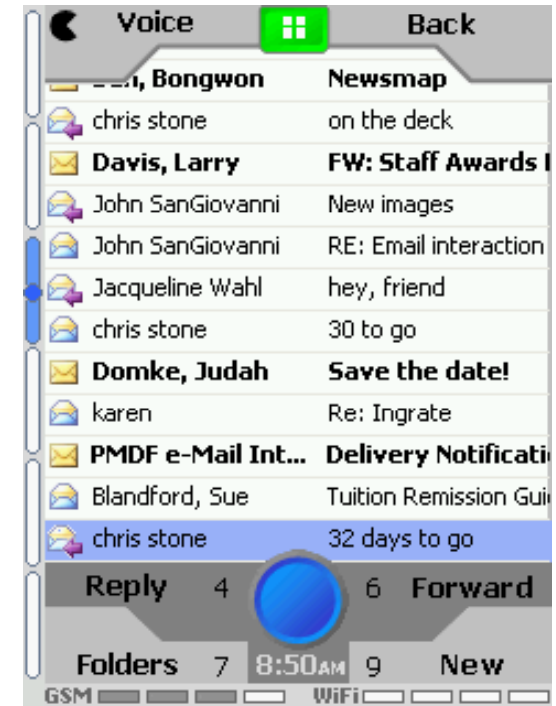
- Three (pure) zoom levels



World



Zone



Application

- “Blue” 

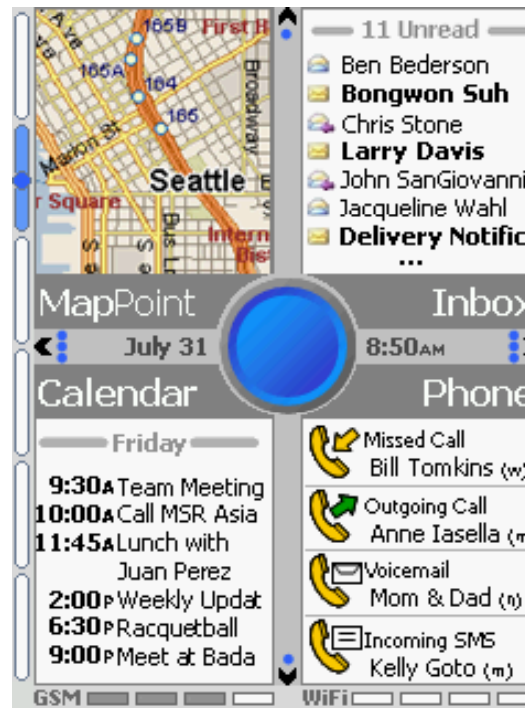
- Navigation Landmarks 

LaunchTile Visual Design

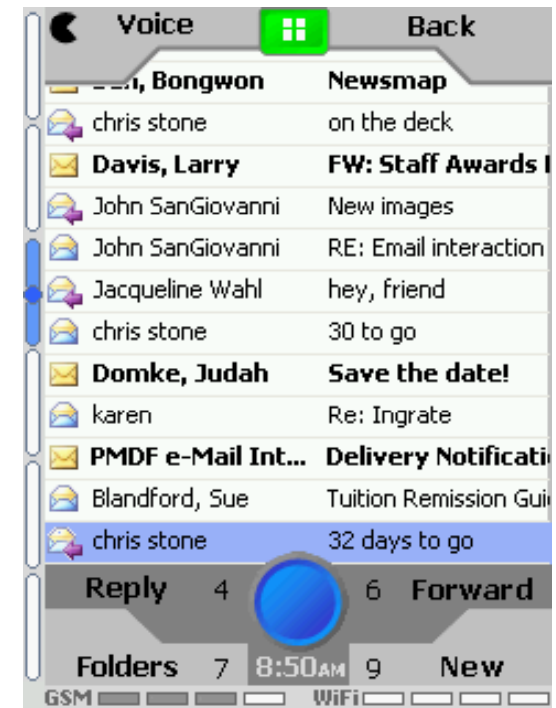
- Three (pure) zoom levels



World



Zone



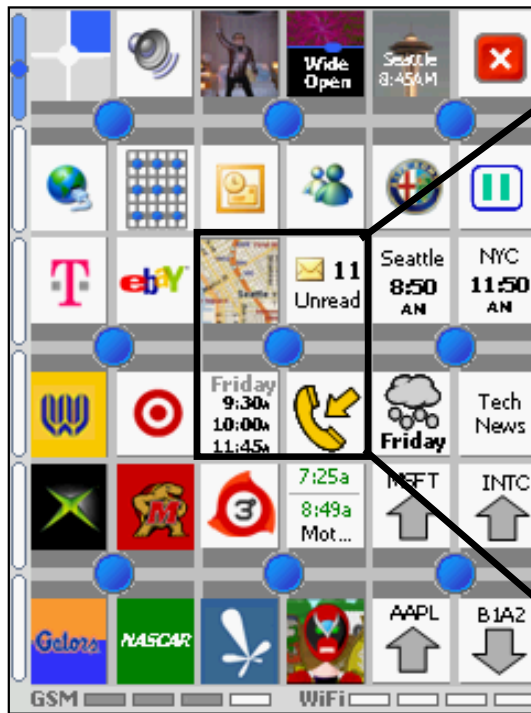
Application

- “Blue”

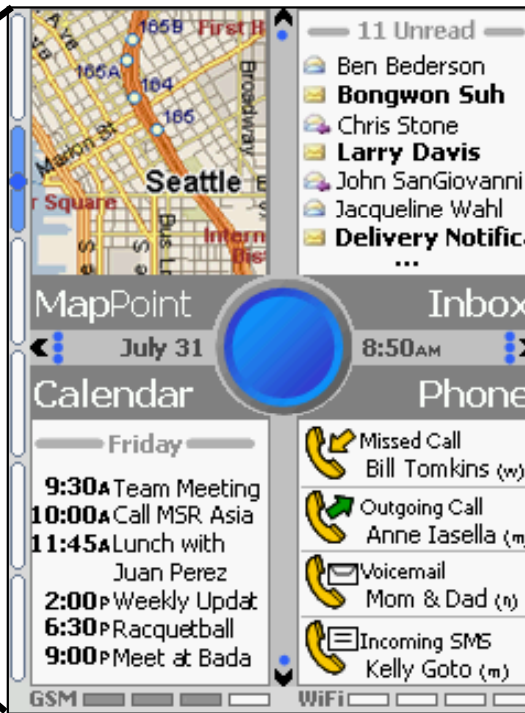
- Navigation Landmarks

LaunchTile Visual Design

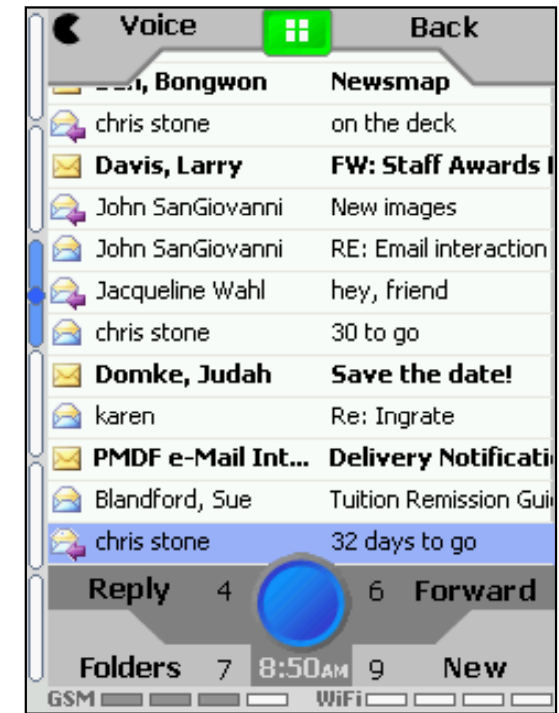
- Three (pure) zoom levels



World



Zone



Application

- “Blue”

- Navigation Landmarks

LaunchTile Visual Design

- Three (pure) zoom levels



World

Zone

Application

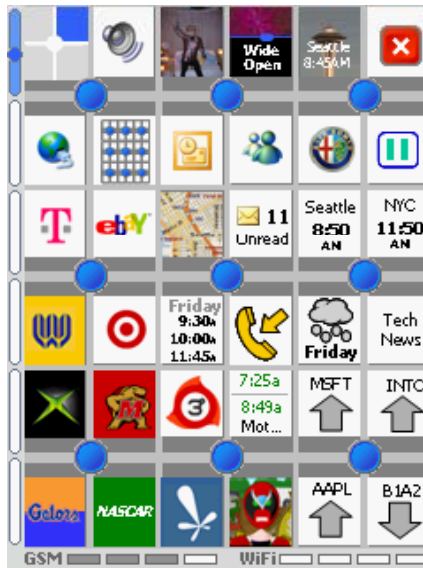
- “Blue”

- Navigation Landmarks



LaunchTile Interaction Design

- Thumb-sized, keypad-mapped targets



World

LaunchTile Interaction Design

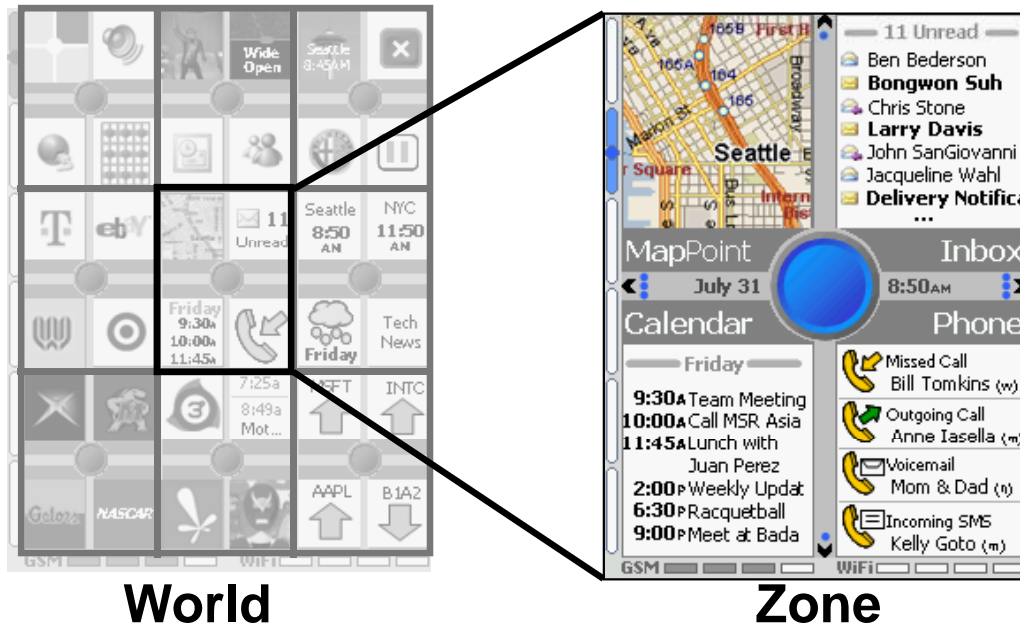
- Thumb-sized, keypad-mapped targets



World

LaunchTile Interaction Design

- Thumb-sized, keypad-mapped targets



LaunchTile Interaction Design

- Thumb-sized, keypad-mapped targets



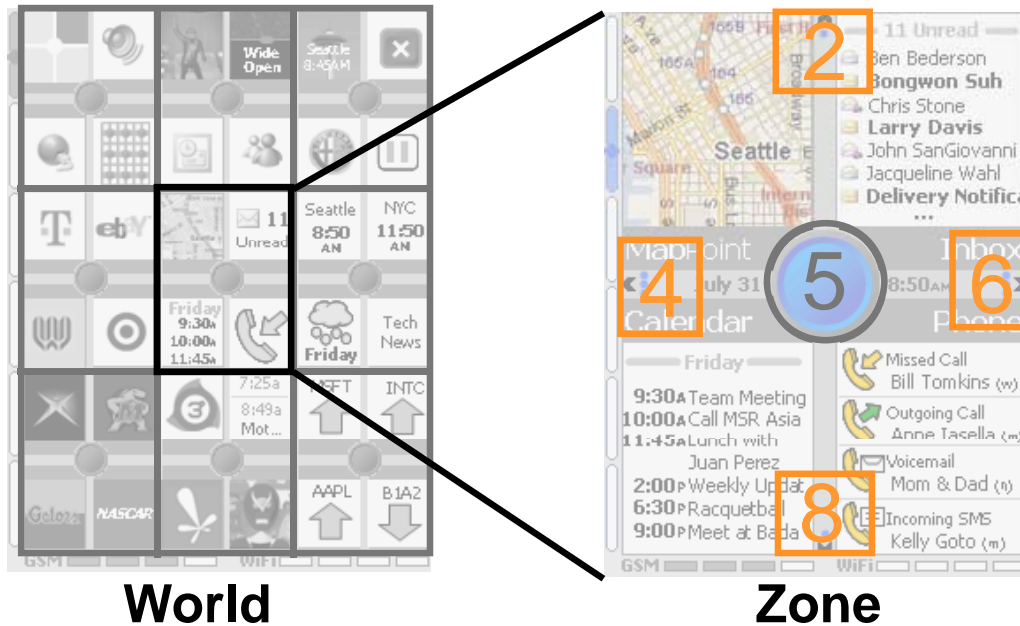
World



Zone

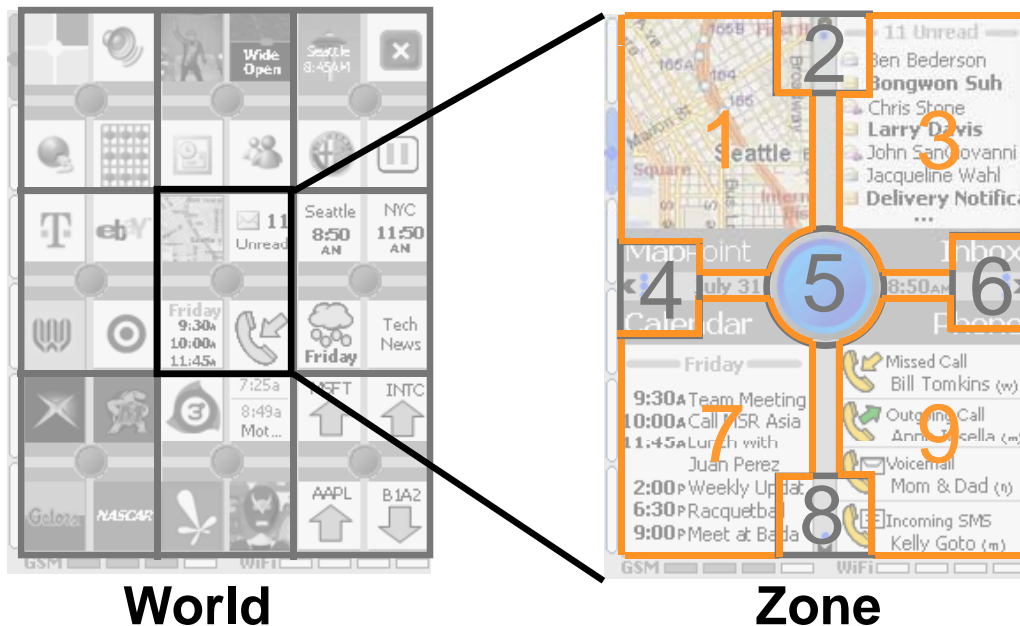
LaunchTile Interaction Design

- Thumb-sized, keypad-mapped targets



LaunchTile Interaction Design

- Thumb-sized, keypad-mapped targets

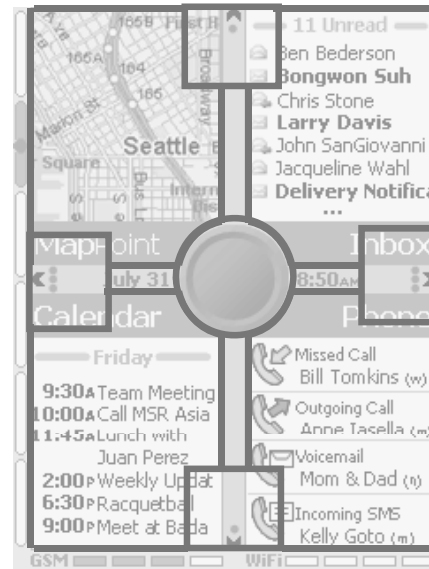


LaunchTile Interaction Design

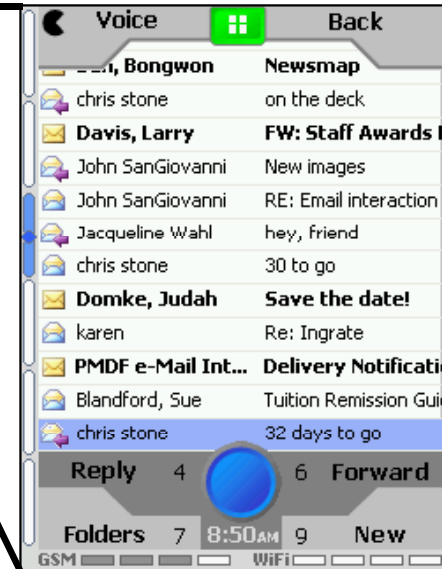
- Thumb-sized, keypad-mapped targets



World



Zone



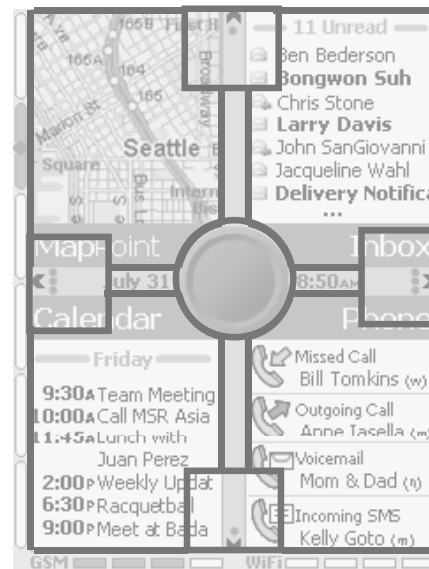
Application

LaunchTile Interaction Design

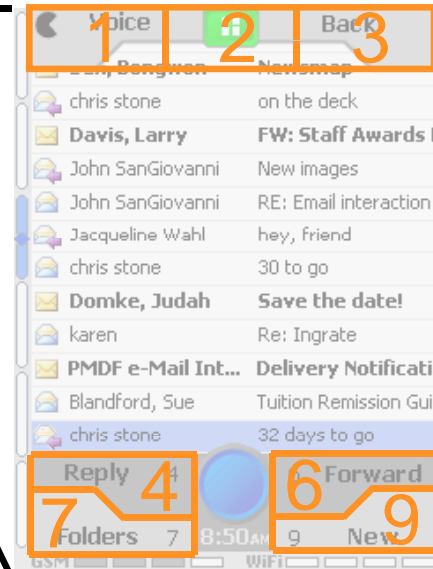
- Thumb-sized, keypad-mapped targets



World



Zone



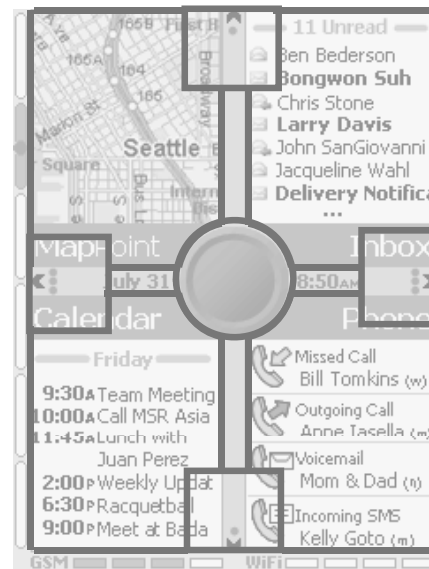
Application

LaunchTile Interaction Design

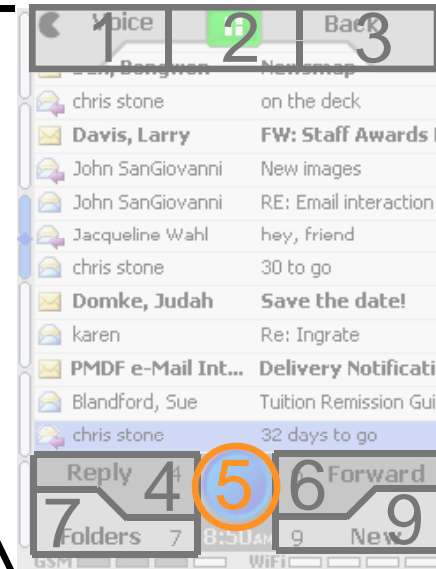
- Thumb-sized, keypad-mapped targets



World



Zone



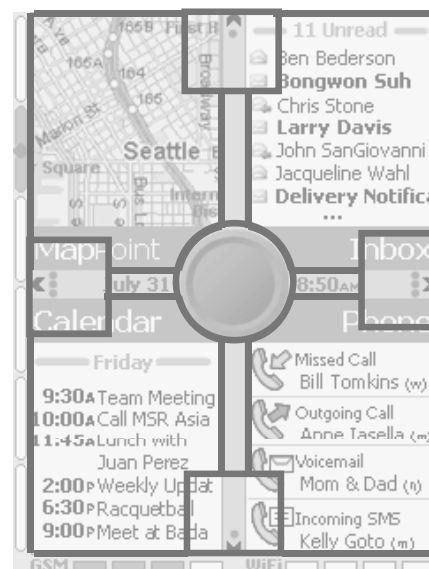
Application

LaunchTile Interaction Design

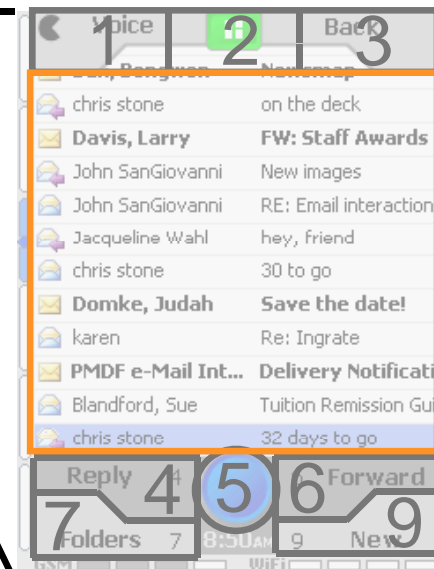
- Thumb-sized, keypad-mapped targets



World



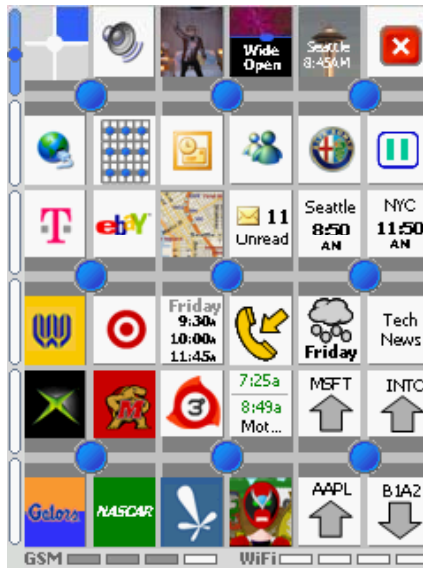
Zone



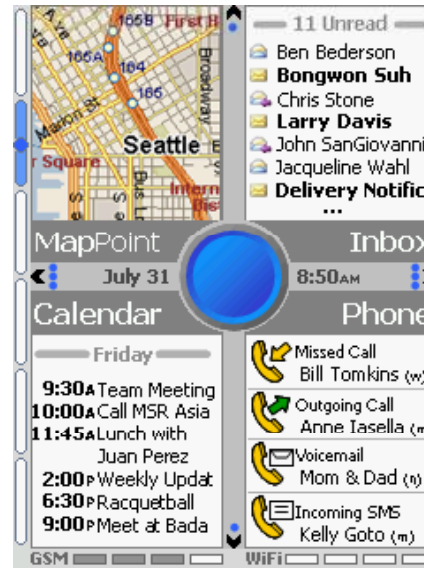
Application

LaunchTile Interaction Design

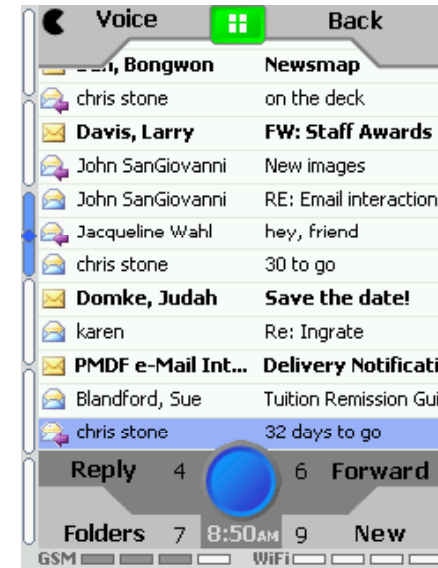
- Thumb-sized, keypad-mapped targets



World



Zone



Application

- Direct Manipulation Drag Gestures

- Zoomspace
- Application content
- Toolglass

LaunchTile Video

Interactive prototype based on images

AppLens Command Gesture Study

- Gestures learnable with minimal training?
- Participants
 - 20 (12 Male, 8 Female)
 - 12 advanced computer users
 - 6 regular PDA users
- Time
 - Training: 5-15 minutes
 - Tasks: 15-30 minutes

Methods

■ Tasks

- Gesture
- Navigation

■ Measures

- Correctness and Speed
- Correctness and Efficiency

■ Environment

- Hierarchical
- Tabular
- Zoomable

Navigation Phase 10:33		
Navigate to 6.5.4		
1	2	3
4	5	6
7	8	9

Navigation Phase 10:34		
Navigate to 6.5.4		
6.5.1	6.5.2	6.5.3
6.5.4	6.5.5	6.5.6
6.5.7	6.5.8	6.5.9

Navigation Phase 10:36		
Activate the 5 in 6.5.4		
6.5.1	6.5.2	6.5.3
6.5.4	6.5.5	6.5.6
6.5.7	6.5.8	6.5.9

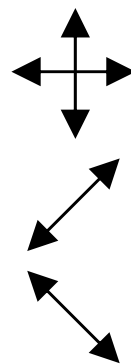
Video

Gesture Study

Results

■ Gesture Tasks

- Directional
- Activate / Cancel
- Backward / Forward



	% Correct	Speed (sec)
Directional	93%	1.2
Activate / Cancel	87%	2.7
Backward / Forward	67%	3.6

■ Navigation Tasks

- 95% correct
- +2.4 gestures per task
- Most of the problems from one third of users

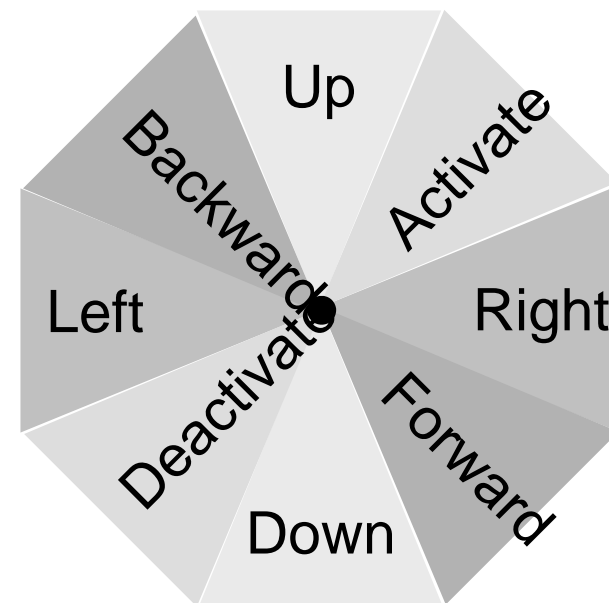
■ Subjective Reactions on 9-Point Scale

- All between 5.9 - 6.75 (9 was best)

Discussion

- Errors from recall or execution?

- Logs indicate both



- Navigation better than Action Gestures

- Spatial mapping helps learnability
- Abstract mappings require more effort
- Similar mappings can be confusing

Formative Study Comparing Designs

■ Goals:

- Usability issues
- Comparative preferences

■ Participants:

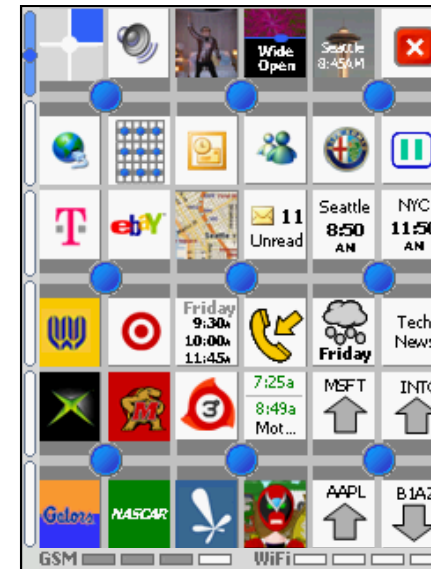
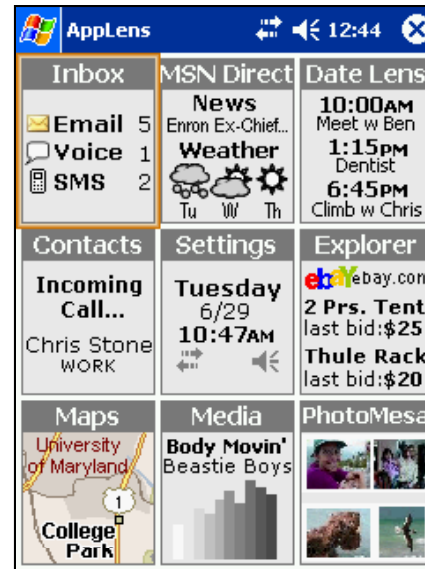
- 10 (8 Male, 2 Female)
- All advanced computer users
- 4 regular PDA users

■ Time:

- 45 minutes: 15 per interface, 15 discussion

Method

- Software:



- Tasks:

- Exercised navigation & interaction features

- Measures:

- Subjective reactions
- Comparative preferences

Results: AppLens

- Likes
 - Easy to learn
 - Effective to navigate
 - Comfortable
 - Fisheye valuable
 - Simultaneous access to apps

- Usability Issues
 - Gestures were hardest part



Results: LaunchTile

■ Likes

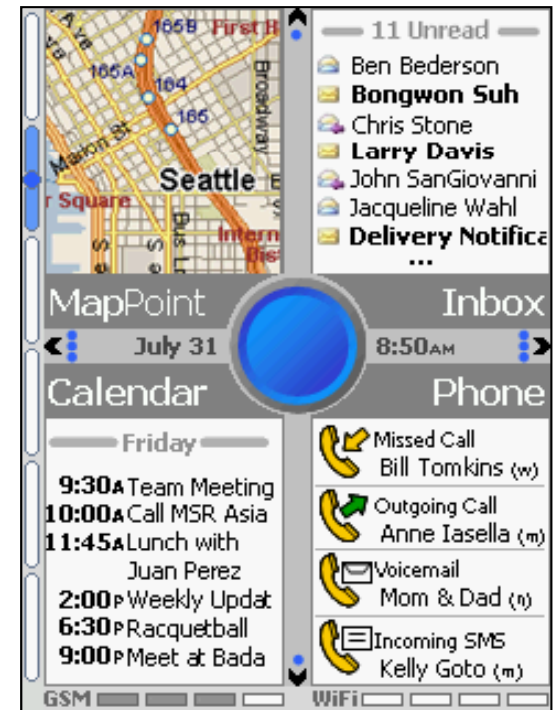
- ❑ Effective to navigate
- ❑ Comfortable
- ❑ “Blue”
- ❑ Access to many apps

■ Dislikes

- ❑ Too many apps

■ Usability Issues

- ❑ Multi-modal “Blue”



- ❑ Disorienting

- ❑ Panning in Zone view

Results: AppLens vs. LaunchTile

- With minimal training, AppLens preferred
 - Easier to use
 - Faster application access
 - Better at-a-glance value
 - For own PDA use

Discussion

- AppLens beats LaunchTile?
 - Not necessarily
 - AppLens was simpler, shallower, fewer apps
 - Easier to learn and manage under time constraints
 - Performance unaffected by device limitations

- General Observations
 - Tapping used more than gestures
 - Utility of notification tiles

Conclusion

- Promising Interfaces:
 - One-handed
 - Notification-based
 - Tappable

 - Unknown:
 - Scalable interfaces

 - Potential Challenge:
 - Gesture-based interfaces
-