Universal Design Practices: Development of Accessible Cellular Phones

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Universal design is the design of products and environments to be usable by all people, ...... (Ron Mace)

Practice of designing products or environments that can be effectively and efficiently used by people with a wide range of abilities ..... (Vanderheiden)

Universal Design is design activities to make products / environments usable for a greatest number of users
Human Centered Design processes
A series of design activities that makes products or systems usable, grounded on users perspective.
Human Centered Design

Benefit
• make products or systems easier to understand and use
• improve user satisfaction and reduce discomfort and stress

Essential
• the active involvement of users
• a clear understanding of user and task requirements
• the iteration of design solutions

Applying HCD for products involving various users
= Practicing Universal Design
Practical Design Processes

HCD processes defined in ISO 13407

1. Understand and specify the context of use
2. Specify the user and organizational requirements
3. Produce design solutions
4. Evaluate designs against requirements

More practical design processes

1. User requirement capture
   - user needs, context of use, ..... 
2. Prototyping
   - deliberation on design specifications, making prototype, evaluation
3. Determining design specifications

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Case Example: Cellular Phone

- Rapid penetration of cellular phones
  - Japan  85 million (as of October, 2004)
  - USA  172 million (as of November, 2004)
  - Brazil  4.4 million in 1977 to 35 million by 2002

- Enhanced functions
  - SMS, E-mail, Web (Interne access), 3G phones

- Regulations
  - Telecommunication Act of 1999 (in the USA)

Cellular phones are;
- becoming a common tool for daily communication tasks.
- becoming an indispensable tool for improving QOL of users with disabilities
User requirement capture (Phase I study)

- Elicitation of information regarding needs, context of use, and other data to support requirements capture

  - **Methods**
    - Individual Interviews (Semi-structured)
    - Focus Groups

  - **Identified needs and user requirements**
    - Needs (Features)
      - Keypad design, Phone size, Audio display, Letters on display, Instruction Manual, Limited functions, ....

    - A part of requirements regarding keypad design
      - Key pitch must increase
      - Key protrusion must be sufficient to allow user orientation
      - Users require kinesthetic feedback of key clicks
      - .....
User requirement capture
(Phase II study)

- Experiment to capture user requirements for keypad design

  Methods
  - Performance testing using low-fi mockups

mockups
User requirement capture
(Phase III study)

- Usability testing of cell phone user interfaces

  - **Methods**
    - Usability testing with retrospective think aloud method (RTA)
      - Users with physical, cognitive, no apparent disabilities
    - Modified usability test with the coaching-learning method
      - Users with visual impairments

  - **Outcomes**
    - General user requirements for cellular phone user interfaces
      (RTA & Coaching-learning)
    - User interface guideline (23 guidelines) (RTA)
    - Design specifications for some features (RTA)
    - Usability problem list (29 problems) (Coaching-learning)
Prototyping
(Product specific study)

- Determining design specification of keypad
  - Methods
    - Product Interactive Focus Group

<table>
<thead>
<tr>
<th>Phone A</th>
<th>Phone B</th>
<th>Phone C</th>
<th>Phone D</th>
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<tbody>
<tr>
<td><img src="image1" alt="Phone A" /></td>
<td><img src="image2" alt="Phone B" /></td>
<td><img src="image3" alt="Phone C" /></td>
<td><img src="image4" alt="Phone D" /></td>
</tr>
</tbody>
</table>

Key protrusion

Key shape

- 0.1 mm
- 0.3 mm
- 0.2 mm
- Convex shape

Body surface

Key
Mean ratings of “Ease of identifying the keys”
Determining specification of audio guidance

Methods
- Focus group

Items prioritized
4. Roaming status, 5. Date and time,
6. Missed call / New message indication,
7. Opening / Closing alarm, 8. Idling confirmation,
9. Key guidance, 10. Outgoing call confirmation, 11. Ringer type,
12. Call-history (outgoing), 13. Call-history (incoming),
14. Call-history (voice mail), 15. Phone book, 16. Quick dial,
17. Speed dial, 18. Accessibility mode,
19. Phone book (navigation), 20. Alarm (navigation)
Prototyping (Product specific study)

- Mean ratings of necessity of audio feedback (Overall)

Strongly Necessary

- [Graph showing mean ratings of necessity of audio feedback for various features]

Not Necessary

Mean ratings of necessity of audio feedback (Overall)

- Strongly Necessary

### Phone Book function
- 19. Phone book (navigation)
- 15. Phone book

### Calling Histories
- 12. Call history (outgoing)
- 13. Call history (incoming)

### Status notification
- 11. Ring tone

### Caller ID
- 17. Speed dial
- 14. Call history (voice mail)

### Other Features
- 1. Battery charge
- 3. Signal strength
- 8. Idle confirmation
- 4. Roaming status
- 5. Date and time
- 2. Battery level
- 10. Outgoing call confirmation
Actual product (Sprint VM4050 by Toshiba)
“it is certainly the most accessible phone that can be purchased off the shelf.” (Access world Vol 5, 4, 2004 May)

- **Keypad**
  Although there is still room for slight improvement, the keys on the VM405 are relatively easy to identify by touch.

- **Audio feedback**
  ......, the fact that they do provide some limited speech output without the need to purchase expensive add-on software is important.
Conclusion

HCD Processes

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Development Processes for VM4050

Phase I
- Requirement capture

Phase II
- Hardware issues

Phase III
- Software issues

- Ten-keypad design
- Audio Guidance

VM4050 (SPRINT)
Conclusion

- Applying HCD processes to product development involving users with a wide range of abilities would be able to enhance accessibility and usability of products.

- HCD processes are effective for practicing universal design, and also efficient for product development.