

# SEEM3510 Human-Computer Interaction

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Week 2 UNIVERSAL USABILITY

# Outline

- Utility
- Usability
- User Experience
- Universal Usability

## A. Utility

- Providing the right kind of functionality so that users can do what they need to do
- Examples
  - Payment APP that links to your bank account or credit card
  - Payment APP that allows you to add the people with whom you have transactions to your FB page

## B. Usability

- ISO 9241 standard Ergonomics of Human-System Interaction provides the definition for usability: *The extent to which a project can be used by specified users to achieve specified goals, with effectiveness, efficiency and satisfaction in a specified context of use*
- NOTE 1 usability relates to the outcome of interacting with a system, product or service. Usability is not an attribute of a product, although appropriate product attributes can contribute to the product being usable in a particular context of use.
- NOTE 2 Usability is a more comprehensive concept than is commonly understood by “ease-of-use” or “user friendliness”.
- Why is usability important?

## B. Usability (cont-1)

Usability is relevant to:

- regular ongoing use, to enable users to achieve their goals effectively, efficiently and with satisfaction
- learning, to enable new users to become effective, efficient and satisfied when starting to use a system, product or service
- infrequent use, to enable users to be effective, efficient and satisfied, with the system on each reuse
- use by people with the widest range of capabilities
- minimizing the risk and the undesirable consequences of use errors and
- maintenance, in that it enables maintenance tasks to be completed effectively, efficiently and with satisfaction.

## B. Usability (cont-2)

- Usability is relevant when designing or evaluating interactions with a system, product or service for the purposes of
  - development
  - procurement
  - review or comparison
  - marketing and market research
- Why is usability important?

# Usability

- Intuitive design
  - Ease of learning
  - Efficiency of use
  - Memorability
  - Error frequency and severity
  - Subjective satisfaction
- 
- ```
graph LR; A[• Intuitive design] --> B[Effectiveness]; A --> C[Ease of Learning]; A --> D[Efficiency]; A --> E[Engagement]; A --> F[Error Tolerance]; B[• Ease of learning] --> C; B --> D; C[• Efficiency of use] --> D; C --> E; D[• Memorability] --> D; D --> E; E[• Error frequency and severity] --> D; E --> F; F[• Subjective satisfaction] --> D; F --> E;
```

# Usability Goals

# Case: Clippy



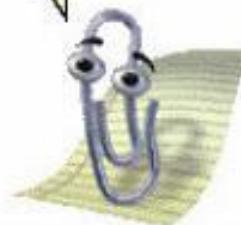
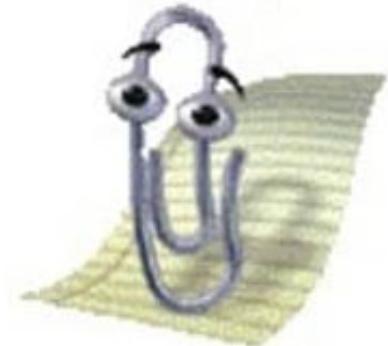
Hi, I'm Clippy! I'm the browser assistant and my job is to help you navigate this page. Do you need assistance?

It looks like you're writing a letter.

Would you like help?

- Get help with writing the letter
- Just type the letter without help

Don't show me this tip again



# Usability – (1) Effectiveness

- Can users complete their goals with a high degree of accuracy?
- Example feature – smart form

**PAYMENT METHOD**

---

 Credit/Debit Card        PayPal

Credit/Debit card number   Secure Form

- Clear and unambiguous language
- Some redundancy in navigation

# Usability – (2) Efficiency

- How fast can the user get the job done?
  - # steps, clicks or keystrokes
- Can they be reduced?
- How do the users prefer to work? (e.g. smartphone/ desktop / smart environment?)

# Usability – (3) Engagement

- Users find it pleasant and gratifying to use
- Aesthetics, appropriateness

# Usability – (4) Error Tolerance

- Hard to eliminate errors completely
- Features to minimize errors
  - Restrict options?
  - Make labels clear and distinct, clear and simple
  - Keep dependent actions together
- Ways to allow easy recovery from errors
  - Allow “undo” and “redo”
- Assume users are going to do things you do not expect them to do

# Usability – (5) Ease of Learning

- Features update
- Metaphors
  - Interactions need to match a user's existing mental model (which is a representation of the real world from the user's point of view)

# Example: using a metaphor

- Line chart, visualizing customer web orders over 2 years



[Source: Keahey 2013]

# Example: using a metaphor

- Visual metaphor (for weekly/monthly patterns)
- Can display few months to a few years in compact space

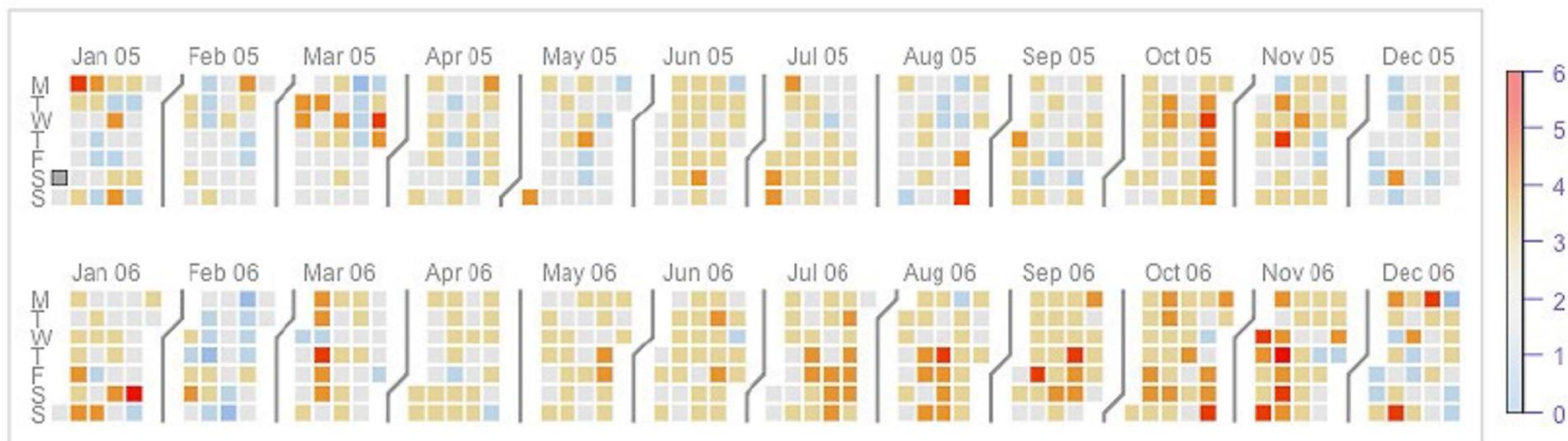


Figure 3: Calendar heat map example that shows two years of changes (in percentages) in customer web orders by year (row), month (column), day of week (sub row), week (sub column) and day.

[Source: Keahey 2013]





Ludwig van Beethoven  
c. 1822-1827

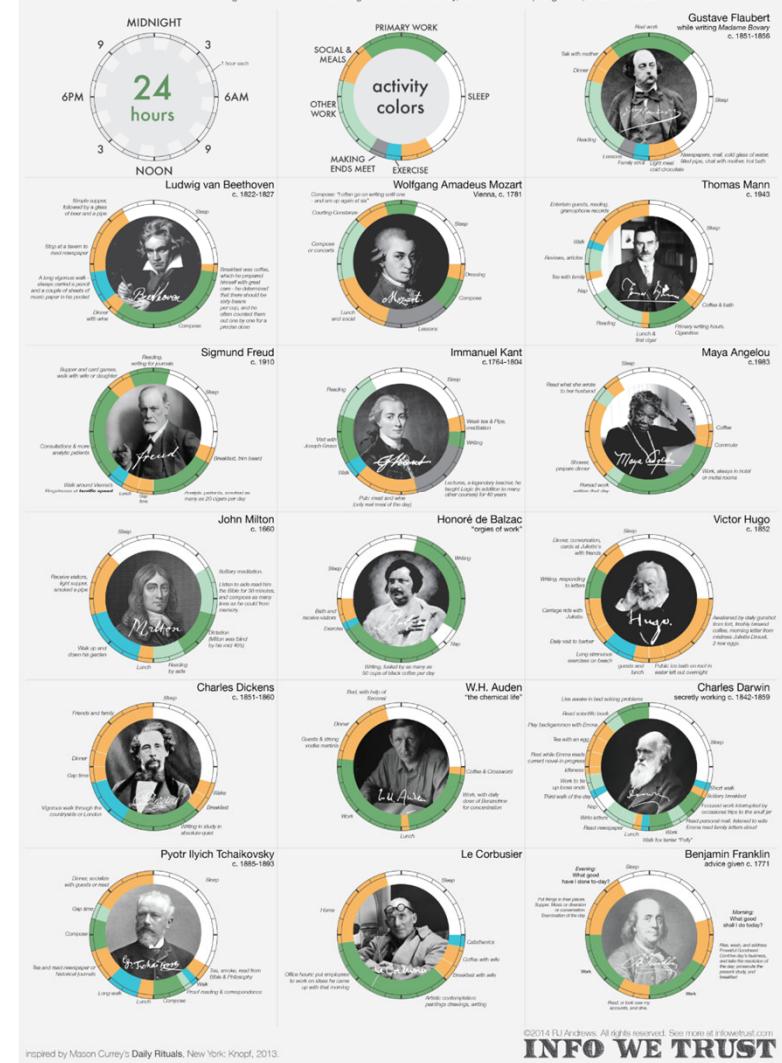


Wolfgang Amadeus Mozart  
Vienna, c. 1781



# CREATIVE ROUTINES

"In the right hands, it can be a finely calibrated mechanism for taking advantage of limited resources... a solid routine fosters a well-worn groove for one's mental energies..." -Mason Currey, author of the inspiring book, DAILY RITUALS



## C. User Experience (UX)

- “User Experience Honeycomb” [Morville]: factors describing UX



# UX

- Useful – from the user's point of view, e.g.
  - virtual museum in education for artists' techniques, spiritual pleasure for visitors (<https://britishmuseum.withgoogle.com/>)
  - computer game to help a student relax after studies
- Usable – enable users to achieve their goals effectively and efficiently
- Findable – orderly structure of information components
  - Follow the user's mental model of the task
- Credible – gaining the user's trust in accomplishing the job, in accuracy, fit-for-purpose, time/resource investment

# UX

- Accessible – people with impairment or are in impairing conditions
  - Hearing, vision, cognitive, motion, learning
- Desirability – branding, image, aesthetics, emotion design
- Valuable – derive value

## Passport photo

Select photo



**X** The photo you want to upload does not meet our criteria because:  
• Subject eyes are closed

Please refer to the technical requirements.  
You have 9 attempts left.

Check the photo [requirements](#).

Read more about [common photo problems](#) and [how to resolve them](#).

After your tenth attempt you will need to start again and re-enter the CAPTCHA security check.

Reference number: 20161206-81

Filename: Untitled.jpg

If you wish to [contact us](#) about the photo, you must provide us with the reference number given above.



Source: Reuters 2016



diri noir avec banan @jackyalcine · Jun 28

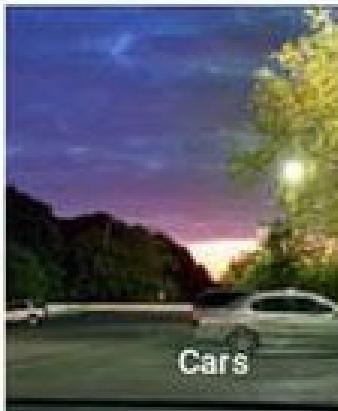
Google Photos, y'all [REDACTED] up. My friend's not a gorilla.



Skyscrapers



Airplanes



Cars



Bikes



Gorillas



Graduation

RETWEETS  
1,031

FAVORITES  
513



23

Source: news.sky.com 2015

## D. Universal Usability

*enabling participation by young and old, novice and expert, able and disabled* -Ben Shneiderman  
**International Consumer Market!!!**

Users are diverse . . .

**Abilities, background, motivations, personalities, culture, work styles, etc.**

- How to design a better interface for all users?
  - Lowest common denominator strategies?
  - Alternative?
- Novice / intermittent / expert users (coming soon)
- Understanding user diversity is vital for expanding market share, enabling creative participation by the broadest possible set of users.



## D. Universal Usability (cont)

Various considerations about **users**:

1. Physical abilities and physical workplaces
2. Cognitive and Perceptual abilities
3. Personality differences
4. Cultural and International Diversity
5. Users with Disabilities
6. Considerations for Elderly
7. Considerations for Children
8. Accommodating hardware and software diversity

Various considerations about **usage contexts**:

1. Broad range of hardware, software, network
2. Broad range of environments

<http://www.usabilityfirst.com/>

The image shows a green-themed web page from usabilityfirst.com. At the top right, there's a small blue banner with the text 'Popular Top'. The main title 'How well do you know your users?' is centered in white text. Below the title is a paragraph of smaller white text: 'For most websites, the answer is probably "not well enough." Learn the proven methods for conducting usability research, including how to apply your findings towards measurable improvements.' A green 'Learn More' button is located at the bottom left of the text area. To the right of the text area is a large grid of numerous small, diverse user portraits.

# 1. Physical Abilities and Physical Workplaces

- Focus on variations
  - Basic data about features of human dimensions comes from research in *anthropometry* (5 to 95 percentile design ranges)
    - Male/female, young/adult, European/Asian, tall/short
    - Size: head, mouth, nose, neck, shoulder, chest, arm, etc.
  - <http://msis.jsc.nasa.gov/sections/section03.htm>  
Application: size of keys in cell phones
  - There is “**no average user**”, either compromises to the UI must be made, or multiple versions of a system must be created
  - Static measurement of human dimensions are not enough: **dynamic measures** such as reach distance, strength, speed, etc. Example – Kinect  
<https://www.youtube.com/watch?v=Z0fOxYU2C7Y>

# Example

- Which one accommodates more diversity in the “user” population?



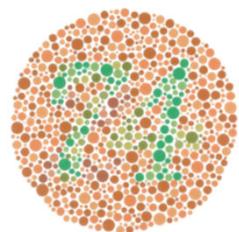
A



B

# Physical Abilities (cont)

- Some common considerations
  - *Screen-brightness* preferences vary substantially, designers customarily provide a knob to enable user control
  - Consider variances of user population's sense perception
    - **Vision**: depth, contrast, color blindness, motion sensitivity, and visual fatigue: [http://en.wikipedia.org/wiki/Color\\_blindness](http://en.wikipedia.org/wiki/Color_blindness)
    - **Touch**: keyboard and touchscreen sensitivity
    - **Hearing**: audio clues must be distinct
    - **Hand control**: Mouse speed and sensitivity



These physical abilities influence elements of the interactive-system design, playing a prominent role in the design of the workspace or workstation (or [playstation](#))

# Physical Abilities and Physical Workplaces (cont)

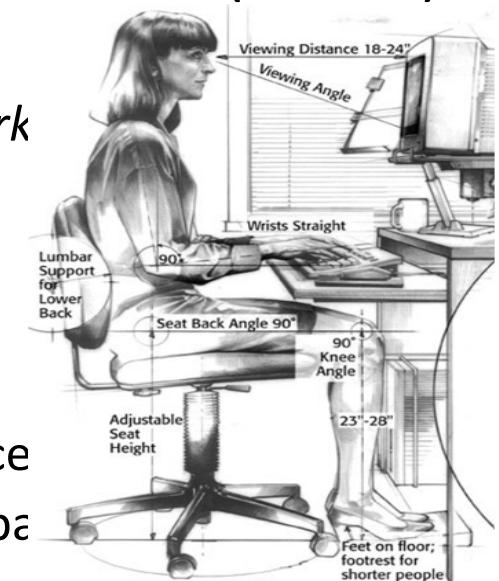
Workplace design issues:

- The draft standard *Human Factors Engineering of Computer Work* (HFES, 2007) lists **these concerns**:

- Work-surface and display-support **height**
- **Clearance** under work surface for legs
- Work-surface **width and depth**
- **Adjustability** of heights and angles for chairs and work surface
- **Posture** - seating depth and angle; back-rest height and lumbar support
- Availability of **armrests, footrests, and palm-rests**
- **Use of chair casters**

- Workspace design is important in ensuring high job satisfaction, high performance, and low error rates.

- Incorrect table heights, uncomfortable chairs, or inadequate space to place documents can substantially impede work



chair casters

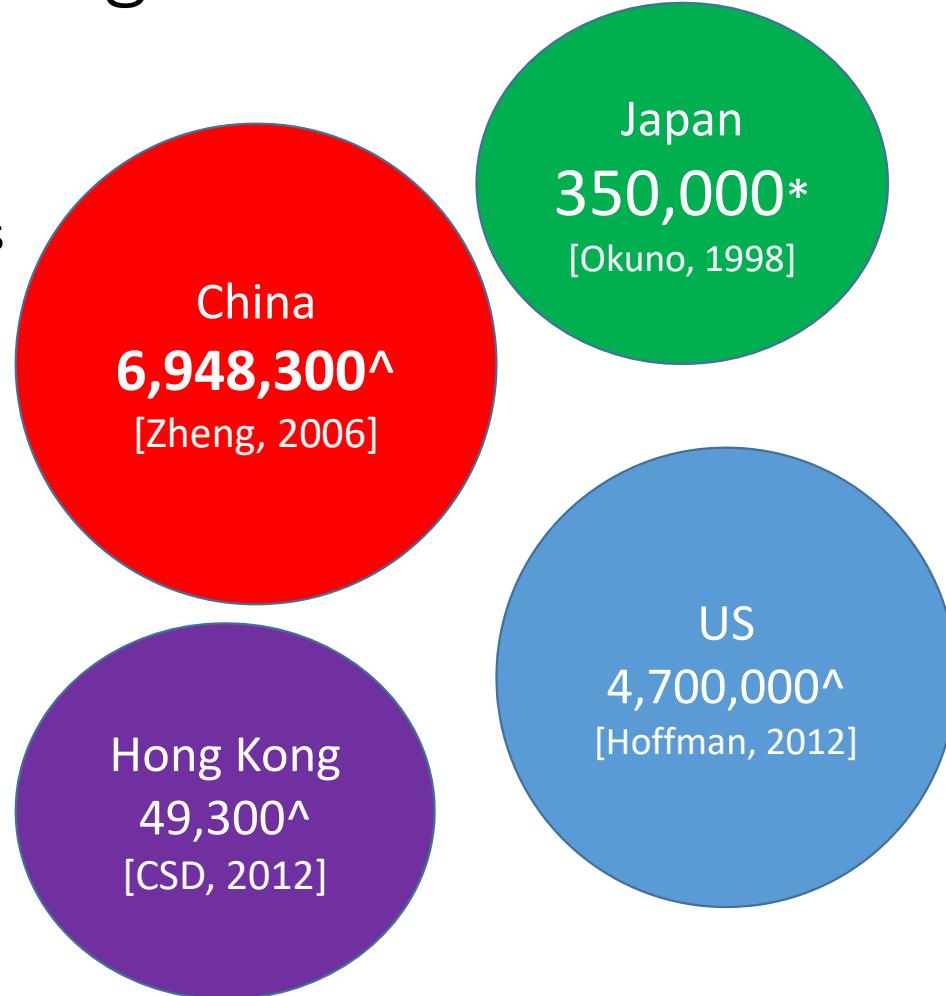
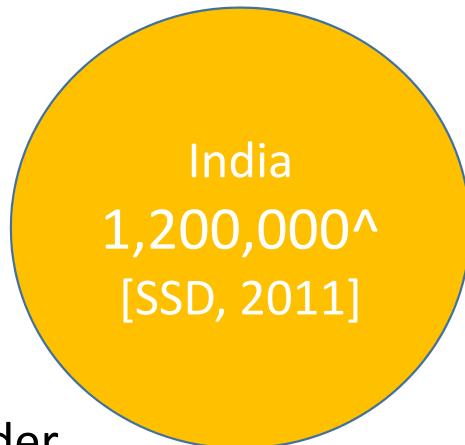
# Physical Disabilities – Assistive Technologies

## Case Study: E-Commu-Book [Meng et al.]

- Motivation: Nearly 50 thousand people in HK have speech difficulty, >40% have no verbal communication at all (CSD '14)
- Collaboration with the Hospital Authority, supported by the Innovation & Technology Commission's Public Sector Trial Scheme
- Speech therapists in HK designed an AAC system called the Communication Book

# Case Study (cont): Background

- Users with speech disorders
  - Male  (“Brotherhood”)
  - Difficulties in their daily activities
  - Huge amount of population in many countries



<sup>^</sup> Speech disorder

\* Hearing and speech impairment

# Case Study (cont): Traditional Communication Book

- Paper (standard) Communication Book from Hospital Authority
- **Inconvenient** (Hardcopy)
  - Heavy, Bulky
  - Time consuming on ordering, printing, and distribution
  - Non traceable of usage behavior
- **Inflexible** (No personalization)
  - Non-adjustable (size)
  - Non-editable (content, order)
- **Non-interactive** (No speech output)
  - Unimodality of communication (visual)
- **Not AI-enabled**



# Case Study: Electronic Communication Book

## Inconvenient (Hard to use)

- Heavy, Bulky
- Time consuming on ordering and delivery
- Non traceable of usage behavior

## Convenient

- Run on Mobile, downloadable from Cloud
- Production cost reduction → **ease of deployment!**
- Usage behavior tracking

## Non-flexible (No personalization)

- Non-adjustable (size)
- Non-editable (content, order)

## Flexible

- Adjustable size of images
- Editable layout and content

## Non-interactive (No speech output)

- Uni-modal communication

## Interactive

- Multimodality of communication (visual + audio)

## Non-adoptable with AI technology

- No automatic text translation
- No intelligent

## Adopted with AI technology

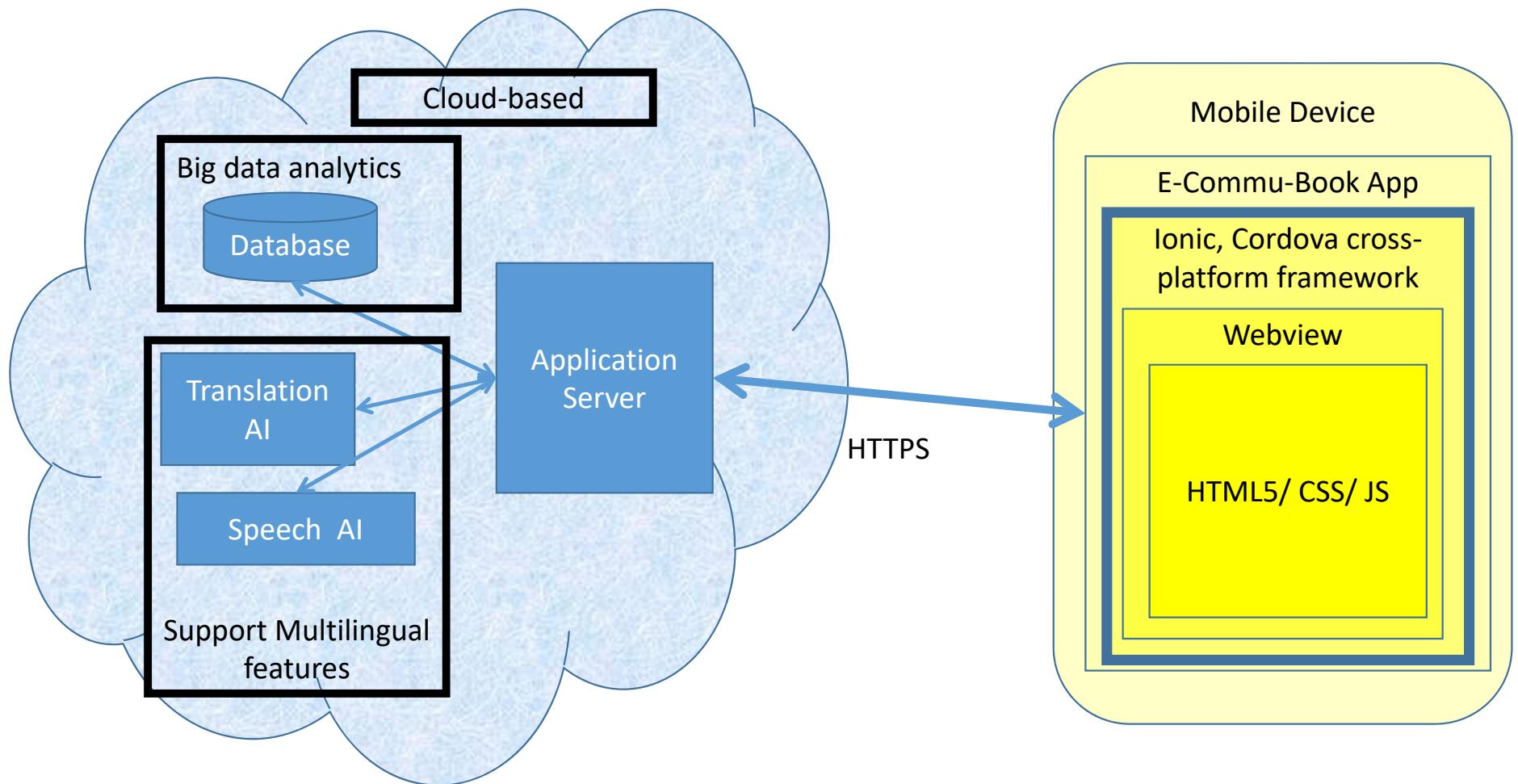
- CUHK's Cantonese Text-to-Speech Synthesizer
- Microsoft Cognitive Services



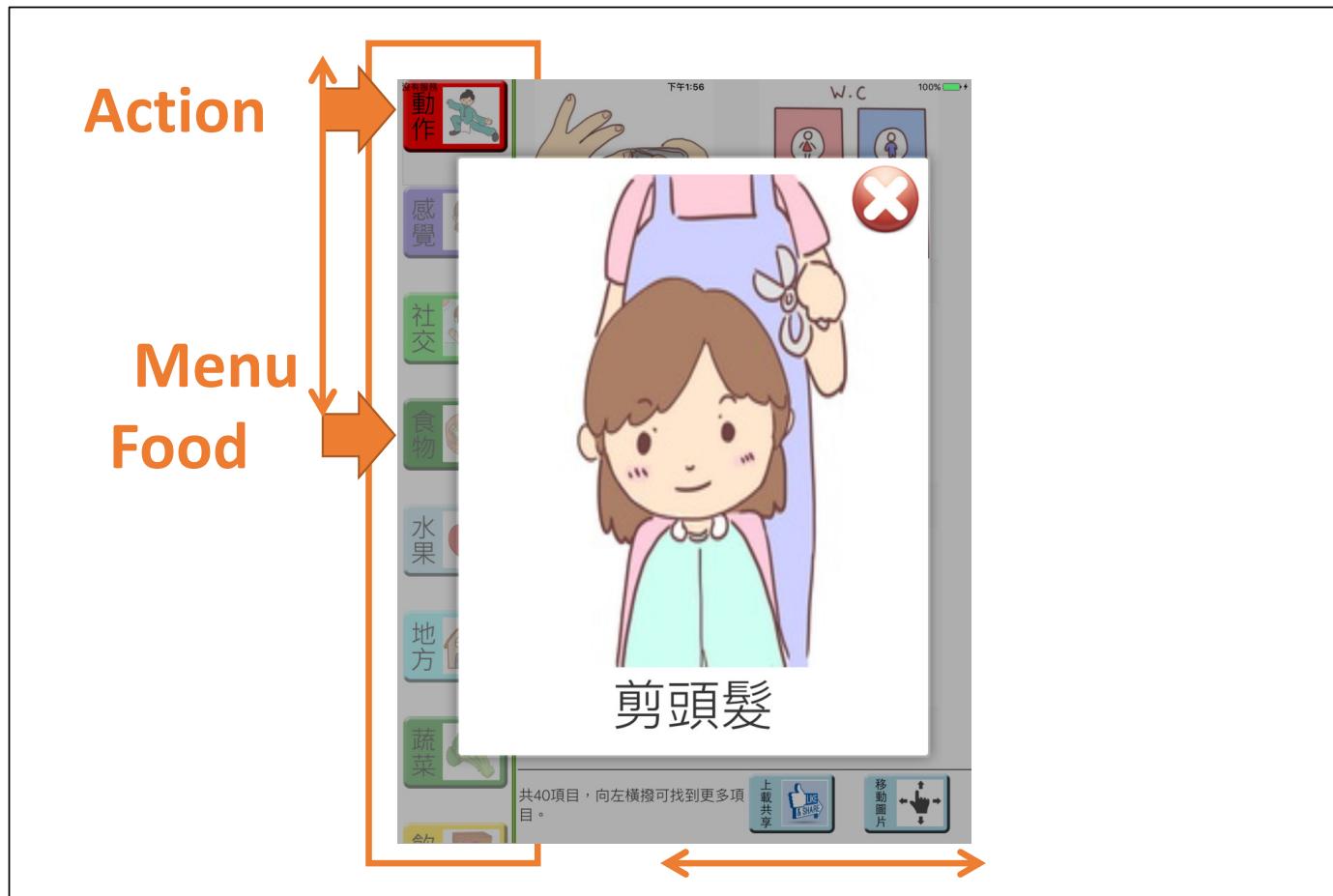
***Improves communication, independence, social inclusion and quality of life***



# Case Study (cont): System Architecture



# Case Study (cont): Designing the E-Version



# Case Study (cont): Personalization Features



# Case Study (cont): Demo

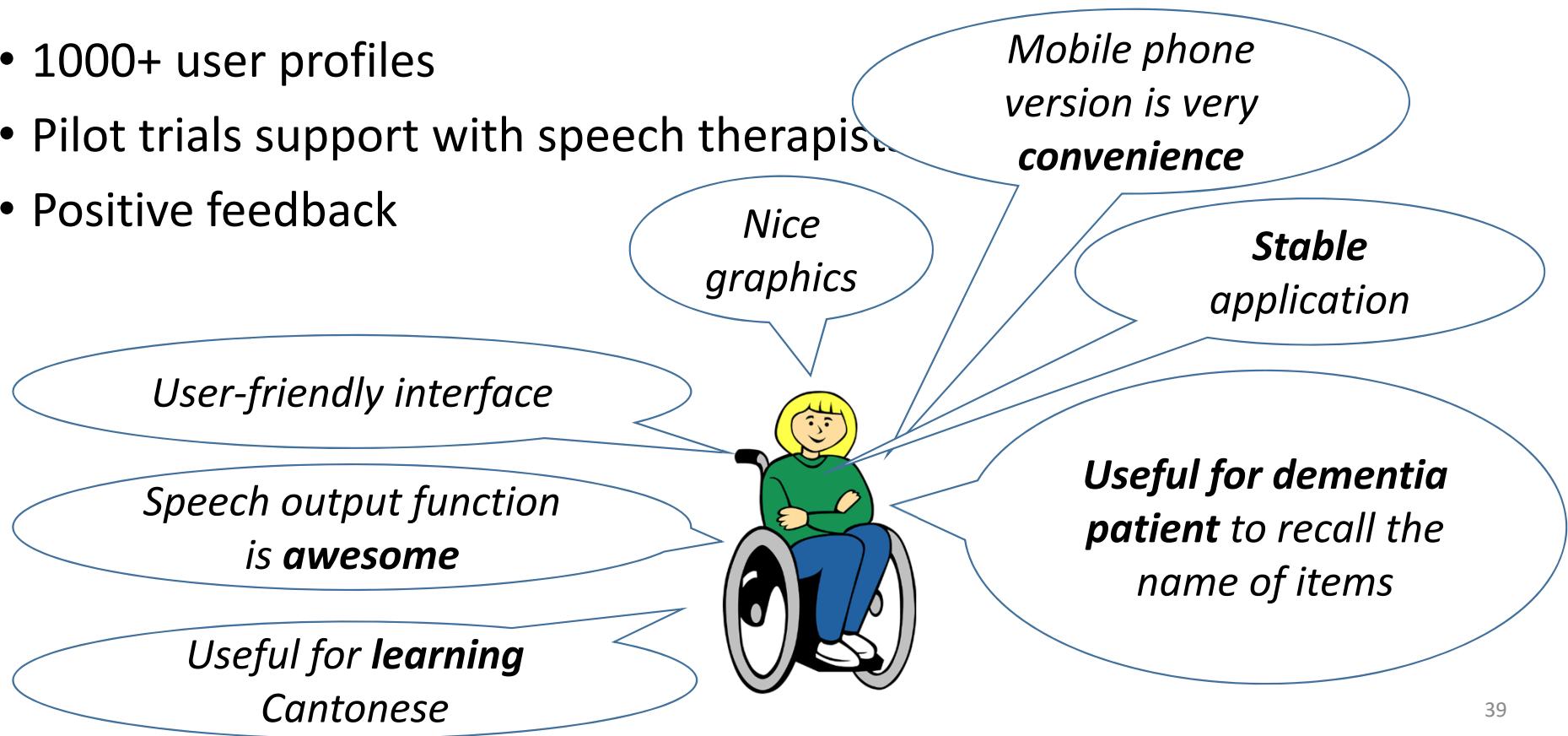


# Case Study: Public Trial



# Case Study (cont): Responses from Target Users

- 1000+ user profiles
- Pilot trials support with speech therapist
- Positive feedback



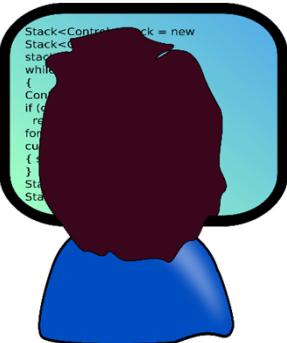
# Case Study (cont): Responses from Organizations

In what area(s) do you think the project results/technology are of benefit to your organization?

- Improve service quality
- Process enhancement

How satisfied are you with the overall performance of the Project Coordinator or project team?

Very thankful to them for providing the product for trial use on patients and on-site support to patients & clinicians



# Case Study: Email from Brooklyn, New York

Reesa Antony Reesa.Antony@downstate.edu via sunydm.onmicrosoft.com  
to khwong@se.cuhk.edu.hk, wkleung@se.cuhk.edu.hk, hongyin.wang@se.cuhk.edu.hk  
14 Jul 2018, 01:03 ☆ ↗ ;  
Good afternoon,  
**e a Chinese speaking patient,**  
I found your article "E-Commu-Book: An Assistive Technology for Users with Speech Impairments" in a research blog and wanted to reach out to you for you help.

**almost 90% unintelligible. He is 100% receptive.**

Currently, he is able to type using Chinese characters and able to type using his cell phone. He has severe dysarthria, almost 90% unintelligible. He is 100% receptive. He is not familiar with any English or the American alphabet.

I tried this patient with the Indi-10 (Tobii Dynavox), however, the Communicator 5 only offers a the English letters for typing with Chinese voice output

**He is not familiar with any English or the American alphabet.**

do appreciate it.

I am located in Brooklyn, New York

Indi-10 (Tobii Dynavox), however, the Communicator 5 only offers a the English letters

Reesa Antony MS CCC-SLP, MPH  
Speech-Language Pathologist  
SUNY Downstate Medical Center  
450 Clarkson Avenue  
Brooklyn, NY 11203

# HKICT Awards 2018



# Case Study (cont) – Summary

- Developed E-Commu-Book to help users with speech disorders
  - **Freely download** from Apple AppStore and Google Play Store
  - **Extendable and personalizable** content and layout
  - **1<sup>st</sup>** to provide sharing feature
  - **1<sup>st</sup>** to adopt with **Speech AI** technology on AAC
    - **Automatic** synthetic voices
    - **Automatic** text translation
    - **Multilingual** support (11+ languages with 20+ gender-specific accented voices)
- **Satisfies** target users
- **Recognized** by international research community and receive HKICT Award in HK
- **Improve quality** of life for target users

# Universal Usability (Recap)

## Topics

1. Variations in physical abilities and physical workplaces
2. Diverse cognitive and perceptual abilities
3. Personality differences
4. Cultural and international diversity
5. Users with disabilities
6. Older adult users
7. Children
8. Accommodating hardware and software diversity

# Diverse Cognitive and Perceptual Abilities

- The journal *Ergonomics Abstracts* offers this classification of human cognitive processes:
  - Long-term and semantic memory
  - Short-term and working memory
  - Problem solving and reasoning
  - Decision making and risk assessment
  - Language communication and comprehension
  - Search, imagery, and sensory memory
  - Learning, skill development, knowledge acquisition, and concept attainment

# Diverse Cognitive and Perceptual Abilities (cont)

- Factors affecting **perceptual** and motor performance:
  - Arousal and vigilance
  - Fatigue and sleep deprivation
  - Perceptual (mental) load
  - Knowledge of results and feedback
  - Monotony and boredom
  - Sensory deprivation
  - Nutrition and diet
  - Fear, anxiety, mood, and emotion
  - Drugs, smoking, and alcohol
  - Physiological rhythms
- IMPORTANT! Background experience and knowledge in the task domain and the interface domain play key roles in learning and performance
  - Novice → Knowledgeable → Power Users

# Perceptual Ability

- Change blindness
- <https://www.youtube.com/watch?v=vJG698U2Mvo>
- [https://www.youtube.com/results?search\\_query=change+blindness+person+swap](https://www.youtube.com/results?search_query=change+blindness+person+swap)
- Significance, e.g. in
  - Social interactions
  - Driving
  - Eyewitness testimony
  - Air traffic control

# Personality Differences

- There is no set taxonomy for identifying user personality types
- Designers must be aware that populations are subdivided and that these subdivisions have various responses to different stimuli
- Personality types:
- [Myer-Briggs: https://www.youtube.com/watch?v=M4YLO-2Tb2w](https://www.youtube.com/watch?v=M4YLO-2Tb2w)
- Others e.g. risk taking vs risk avoidance, internal vs external locus of control, reflective vs impulsive, convergent vs divergent thinking, high vs low anxiety, tolerance (of stress, ambiguity), motivation, compulsive, etc.

# Cultural and International Diversity

- Characters, numerals, special characters, and diacritics
- Left-to-right versus right-to-left versus vertical input and reading
- Date and time formats
- Numeric and currency formats
- Weights and measures
- Telephone numbers and addresses
- Names and titles (Mr., Ms., Mme.)
- Social-security, national identification, and passport numbers
- Capitalization and punctuation
- Sorting sequences
- Icons, buttons, colors
- Pluralization, grammar, spelling
- Etiquette, policies, tone, formality, metaphors

# Users with Disabilities

- Designers must plan early to accommodate users with disabilities
- Early planning is more cost efficient than adding on later
- Growing world-wide support, for example:
  - United Nations Convention on the Rights of Persons with Disabilities (CRPD), an international human rights agreement (<http://www.un.org/disabilities/convention/conventionfull.shtml>)
  - European Union Mandate 376 will require procurement and development of accessible technologies by EU governments (<http://www.mandate376.eu/>)
  - Businesses must comply with the "Americans With Disabilities Act" for some applications

# Users with Disabilities

- A user with disability is using a television with the help of assistive technology



Example: For speech impaired  
CUHK Demo  
[Yu, Liu, Meng et al. 2018]

The image shows a video player interface with a black header containing the word "ADHESION". Below the header is a video frame of a young person with dark hair, wearing a red hoodie, speaking. A circular play button is overlaid on the video. At the bottom of the video frame is a progress bar showing "11:30 / 18:26". To the right of the video frame are three transcription results:

| System              | Original transcript | CUHK System | Google API | Human        |              |        |       |       |          |           |
|---------------------|---------------------|-------------|------------|--------------|--------------|--------|-------|-------|----------|-----------|
| Original transcript | ABSORB              | ADHESION    | ADJACENT   | ADVANTAGEOUS | AGRICULTURAL | ALLURE | ALOFT | ALOOF | ALTHOUGH | ANXIETIES |
| CUHK System         |                     | WORD        | ADHESION   |              |              |        |       |       |          |           |
| Accuracy: 77.6%     |                     |             |            |              |              |        |       |       |          |           |
| Google API          |                     | ZORB        | ADHESION   |              |              |        |       |       |          |           |
| Accuracy: 51.7%     |                     |             |            |              |              |        |       |       |          |           |
| Human               |                     | LORD        | ADHESION   |              |              |        |       |       |          |           |
| Accuracy: 47.1%     |                     |             |            |              |              |        |       |       |          |           |

# Older Adult Users

- As the world's population ages, designers in many fields are adapting their work to serve older adults, which can benefit all users
- Designers should allow for variability in settings, e.g.
  - Larger text
  - Brighter symbols
  - Louder sounds
  - Clearer navigation paths
  - More Consistent layouts
  - Less distracting information
- Example: Design for elderly users

<https://www.youtube.com/watch?v=uP6lbeggAeo&t=11s>

# Children

- Emphasize entertainment and education
- Abilities change with age:
  - **Evolving dexterity:** mouse-dragging, double-clicking, or small targets cannot always be used
  - **Emerging literacy:** instructions and error msgs are not effective
  - **Low capacity for abstraction:** complex sentences must be avoided.
- Aspirations  
(of developers of children's software)
  - Educational acceleration
  - Socialization with peers
  - Psychological - improve self-image, self-confidence
  - Creativity – art, music, etc. exploration



<http://www.youtube.com/watch?v=MGMsT4qNA-c>

# Considerations for Children

- Teenagers are a special group
  - Next generation
  - *Beta tester* for new interfaces, trends
  - Hand phones, text messages, simulations, fantasy games, virtual worlds
- Requires Safety – access to children
- Children
  - Like exploring (easy to reset state)
  - Do not mind making mistakes
  - Like familiar characters and repetition
    - Sometimes re-play a game, re-read a story, or re-play a music dozens of times, even after adults have tired
  - Do not like patronizing comments, inappropriate humor



<http://www.youtube.com/watch?v=1mIOEgF3Myg>



Entertainment Software Rating Board (ESRB): <http://www.esrb.org/>

# Accommodating hardware and software diversity

- Three of the main technical challenges will be:
  1. Producing satisfying and effective Internet interaction on high-speed (broadband) and slower (dial-up and some wireless) connections
  2. Responsive design enabling access to web services from large displays ( $3200 \times 2400$  pixels or larger) and smaller mobile devices ( $1024 \times 768$  pixels and smaller)
  3. Supporting easy maintenance of or automatic conversion to multiple languages

# Summary

- User Interfaces are very important
  - Truly affects aspects of our lives
- Considerations
  - Usability Requirements: What are the tasks and goals of the UI
  - Usability Measurements: Quantitative factors for good UI
  - Usability Motivations
    - Different app. types (life critical, business, home/office, . . . )
  - Issues for Universal Usability (different user groups)
    - Considerations for various user populations
    - (Disabled, elderly, children, etc . . . )

## Additional Reference:

*The Basics of User Experience Design*, Interaction Design Foundation