

# User Interface Design & Implementation

## *Usability*

Week 2 – Lecture 4

January – May Term, 2020

**Assigned Reading:** Chapter 1, 2

# Today's Topics

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- What is usability?
- Usability measures
- Usability requirements
- Usability motivations
- Universal usability

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- **What is usability?**
- Usability measures
- Usability requirements
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# User Interface

A **user interface** is a system that helps users communicate with the computer system and/or the application system

- what the system looks like
- how the system accepts input from the user
- how the system responds to user input
- how the system outputs the results of processing

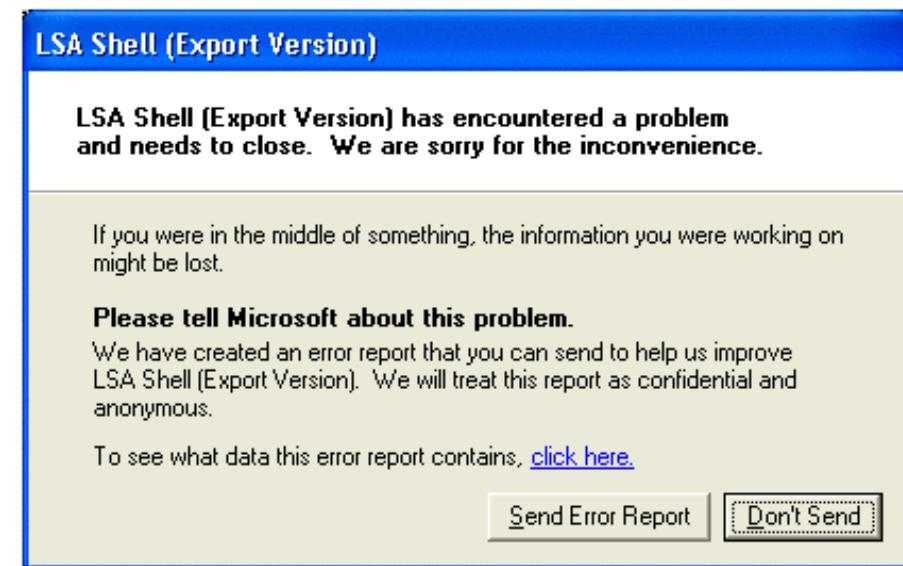


# User Interface

User interfaces make our daily and/or collective lives either pleasant or frustrating



Pleasant

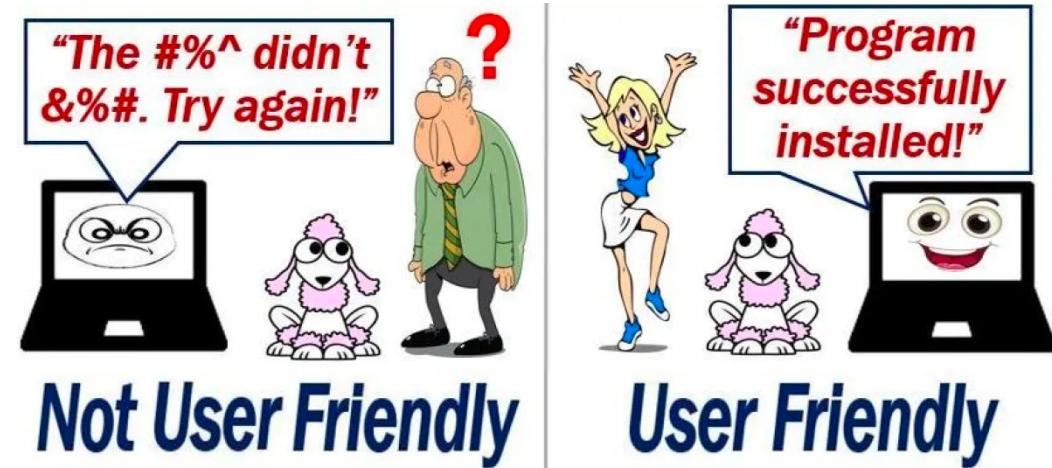


Frustrating

# We have all heard “User-Friendly”

- Definitions for “user-friendly” can be:

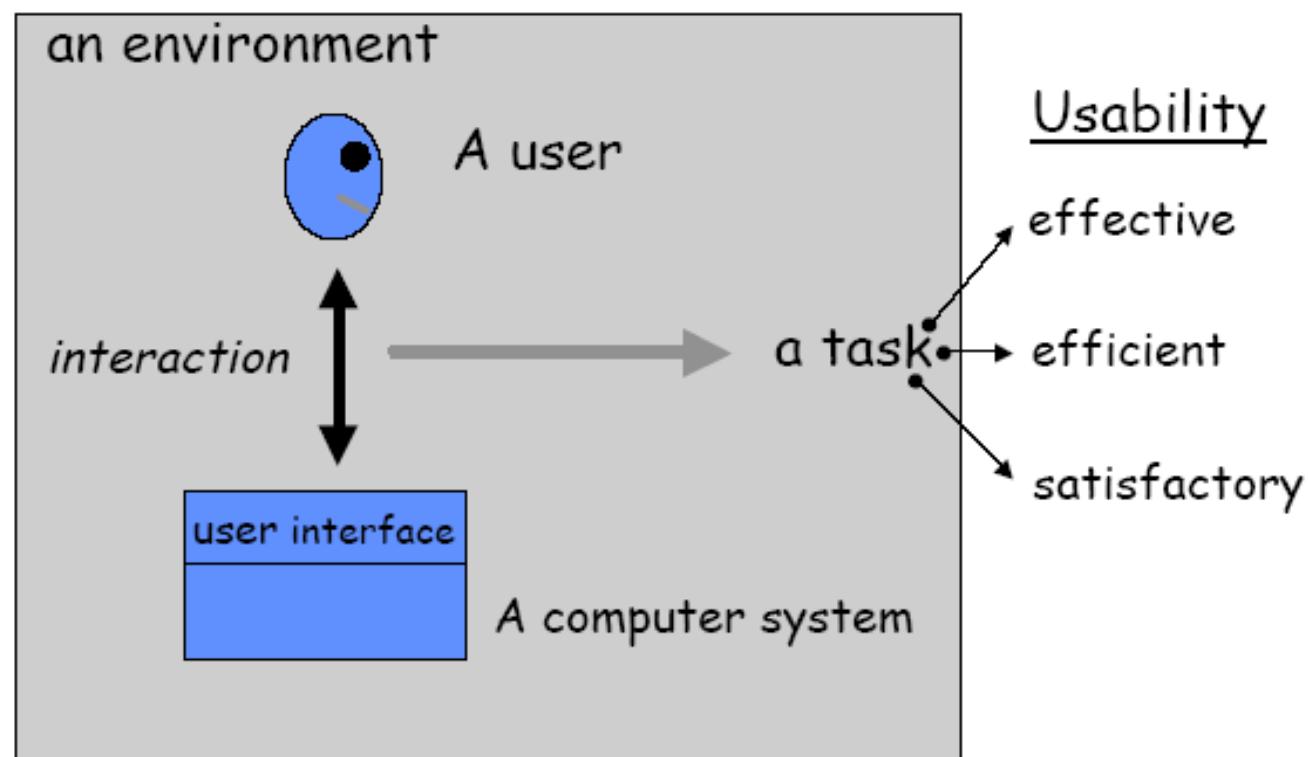
- Easy to use
- Intelligible
- Idiot proof
- Accessible
- Comprehensible



- The above definitions are subjective and vague. Instead, a systematic process is necessary to develop a usable system, not just say “lets make it user friendly”

# What is Usability?

**Usability** = “...the extent to which a product can be used by **specified users** to achieve **specified goals** with effectiveness, efficiency and satisfaction in a specified context of use.” – *ISO Definition (9241-11)*



# What is Usability?

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Usability is defined by **five quality components**:

- **Learnability:** How **easy** is it for users to accomplish basic tasks the first time they encounter the design?
- **Efficiency:** How **quickly** can users perform tasks, once they have learned the design?
- **Errors:** How many errors do users make, how severe are these errors, and how easily can they **recover** from the errors?
- **Memorability:** When users return to the design after a period of not using it, how easily can they **re-establish** proficiency?
- **Satisfaction:** How **pleasant** is it to use the design? 

# What is Usability?

- Learnability
- Efficiency
- Errors
- Memorability
- Satisfaction

The screenshot shows a search results page for 'chairs' and 'stools' on IKEA.com. The interface includes a header with the IKEA logo and navigation links for Products, Shop by room, Inspiration, Happening now, Offers, and a search bar. Below the header, there are filters for Price, Colour, Shape, Seats, Measurements, and More filters. A 'Sort by' dropdown is also present. The main content area displays 806 results, showing various chair and stool models with their names, descriptions, prices, and availability status (e.g., 'New', 'From lower price'). The products shown include VEDBO Armchair (\$249), ODGER Swivel chair (\$169), LEIFARNE Swivel chair (\$75), NORDKISA Bench (\$149), MARIUS Stool (\$5.90), RENBERGET Swivel chair (\$79), NISSE Folding chair (\$19.90), and FLINTAN Office chair (\$89). The bottom of the page features a 'Web feedback' button.

[IKEA.com](http://IKEA.com)

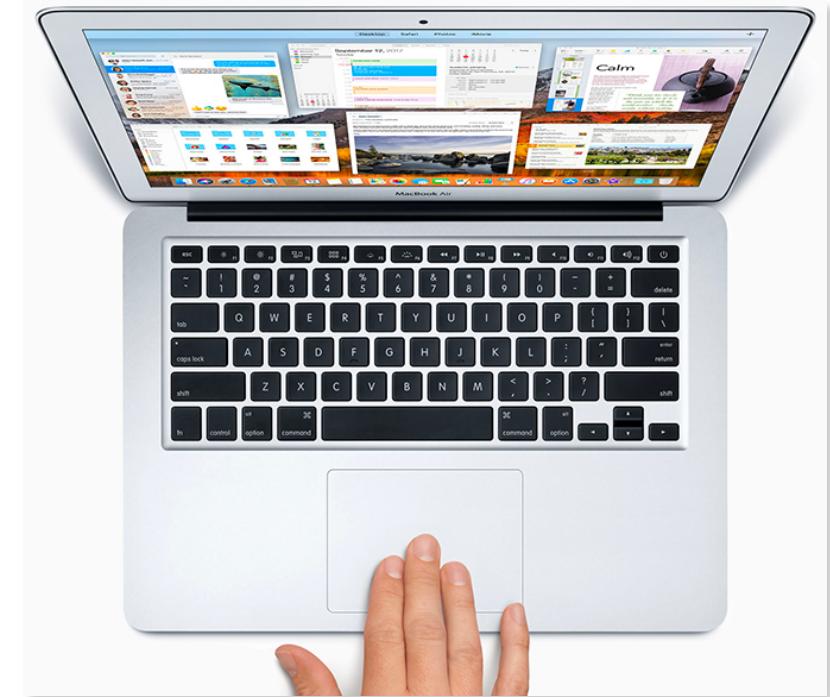
The screenshot shows a cluttered website for ARNGREN.net. The top navigation bar includes links for 'Teknologi & Gadgets' and 'Index'. The main content area is filled with numerous product listings, many of which are highlighted with red price tags. The products include a 'Trådløs Kamera m/ Alarm & GSM' for 1999,-, a 'Trådløst Kamera' for 499,-, a 'Tau & Brann-Båt' for 598,-, a 'El-bil til Posten' for 79.998,-, and various electronic items like 'Disko-Lys', 'Hobby & RC', and 'Oppladbar-Lykt (15mill.)'. There are also sections for 'Forbruker Elektronikk', '44 Språk-Talende Oversetter m/Norsk', and 'Elektriske-Biler til Barn, Ung'. The website has a colorful, busy design with many small images and text snippets.

# What is Usability?

- Learnability
- Efficiency
- Errors
- Memorability
- Satisfaction



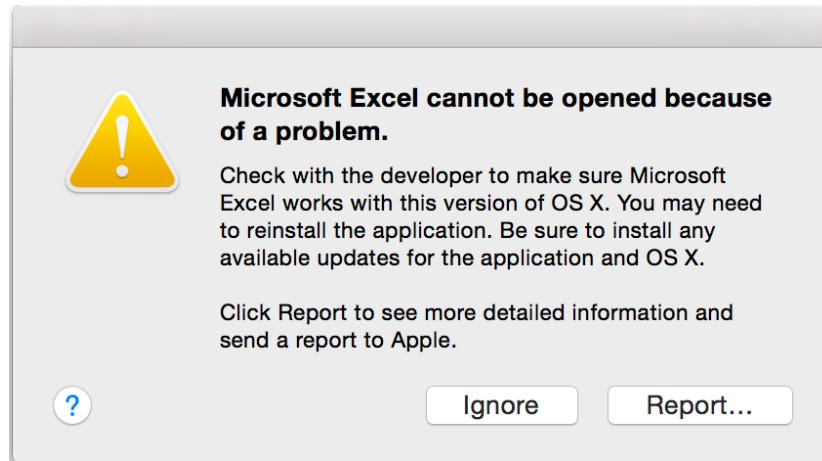
ThinkPad touch pad



MacBook touch pad

# What is Usability?

- Learnability
- Efficiency
- Errors
- Memorability
- Satisfaction



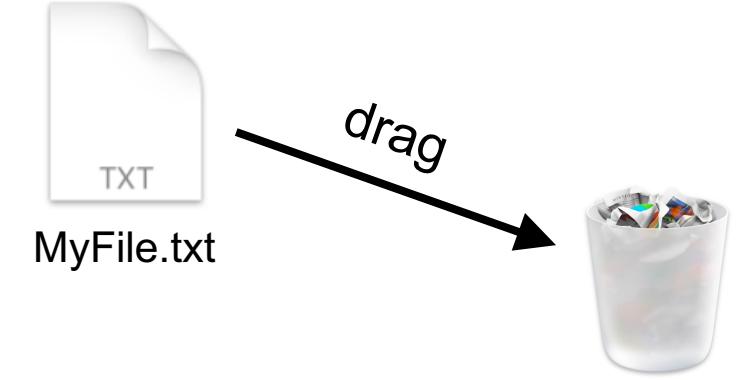
report your problem and mention this error message and the query that caused it. That's all we know.' To the right of the text is a cartoon illustration of a broken robot or machine, with various mechanical parts like gears, bolts, and a wrench scattered around it."/&gt;

# What is Usability?

- Learnability
- Efficiency
- Errors
- **Memorability**
- Satisfaction

*del MyFile.txt*  
or  
*rm MyFile.txt*

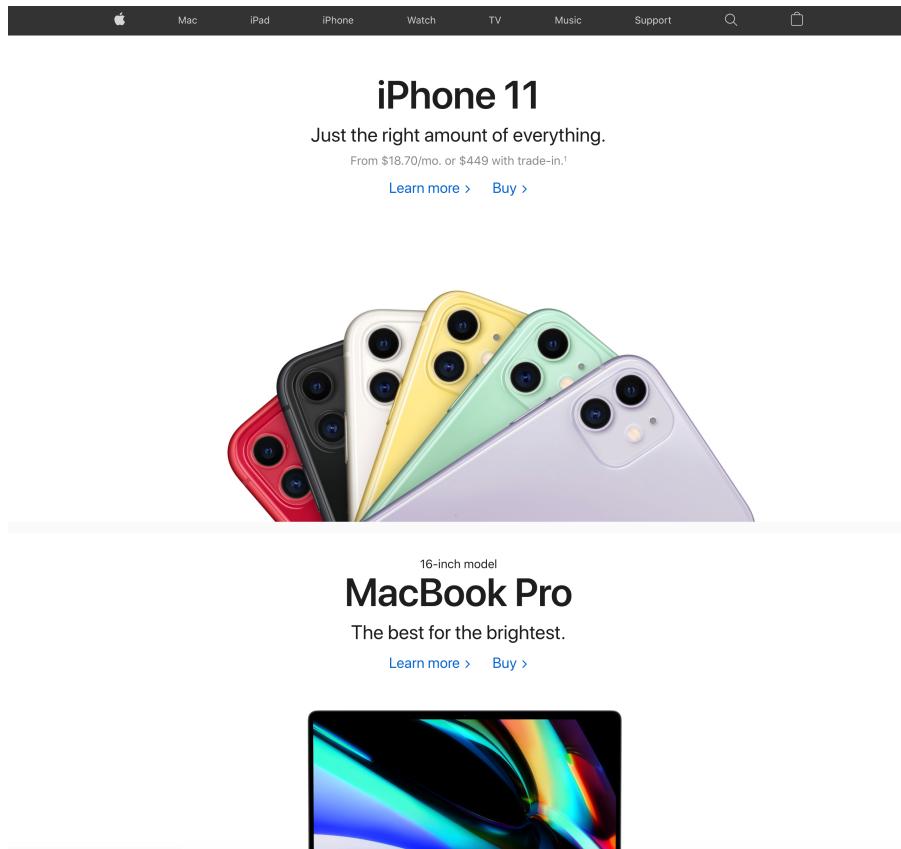
Command line interface



Graphical user interface

# What is Usability?

- Learnability
- Efficiency
- Errors
- Memorability
- Satisfaction



[Apple.com](#)

The image shows the Craigslist website interface for Austin, TX. The top navigation bar includes links for "post to classifieds", "my account", "search craigslist", and a search bar. Below the search bar is a "event calendar" showing dates from 1 to 28. The main content area is divided into several categories: "community" (activities, artists, childcare, classes, events, general, groups), "personal ads" (strictly platonic, women seeking women, men seeking women, misc romance, casual encounters, missed connections, rants and raves), "for sale" (antiques, appliances, arts+crafts, auto parts, baby+kid, barter, beauty+itch, furniture, garage sale, general, heavy equip, household, jewelry, materials, motorcycles, music instr, photo-video, rvs+camp, sporting, tools, toys+games, trailers, vehicles, wanted), "discussion forums" (apple, art, atheist, autos, beauty, bikes, celebs, comp, crafts, diet, divorce, dying, eco, educ, feedbk, files, fitness, fixit, food, frugal, gaming, garden, haiku, help, history, housing, jobs, jokes, kink, legal, linux, mmm, manners, marriage, media, money, motoc, music, nonprofit, open, outdoor, over 50, parent, pets, philos, photo, p.o.c., politics, psych, queer, recover, romance, science, spirit, sports, tax, travel, tv, vegan, w4w, wed, wine, women, writing, yoga), "services" (automotive, beauty, cell/mobile, computer, creative, cycle, event, farm+garden, financial, household, labor/move, legal, lessons, marine, pet, real estate, skilled trade, sm biz ads, therapeutic, travel/vac, write/ed/tran), and "gigs" (computer, creative, crew, domestic, event, labor, talent, writing). On the far right, there's a sidebar with "english" selected under "nearby cities" and a list of cities including Abilene, Beaumont, Brownsville, etc.



# Concepts Related to Usability

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- Usability measures
  - measure five quality components of an interface
- Usability requirements
  - expectations and specifications designed to ensure that a UI is easy to use
- Usability motivations
  - actual usability requirements motivated by applications
- Universal usability
  - designed UI is usable by all people

# Today's Topics

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- What is usability?
- **Usability measures**
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# Usability Measures

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Five quality components of usability

1. *Learnability*
2. *Efficiency*
3. *Errors*
4. *Memorability*
5. *Satisfaction*

# Usability Measures

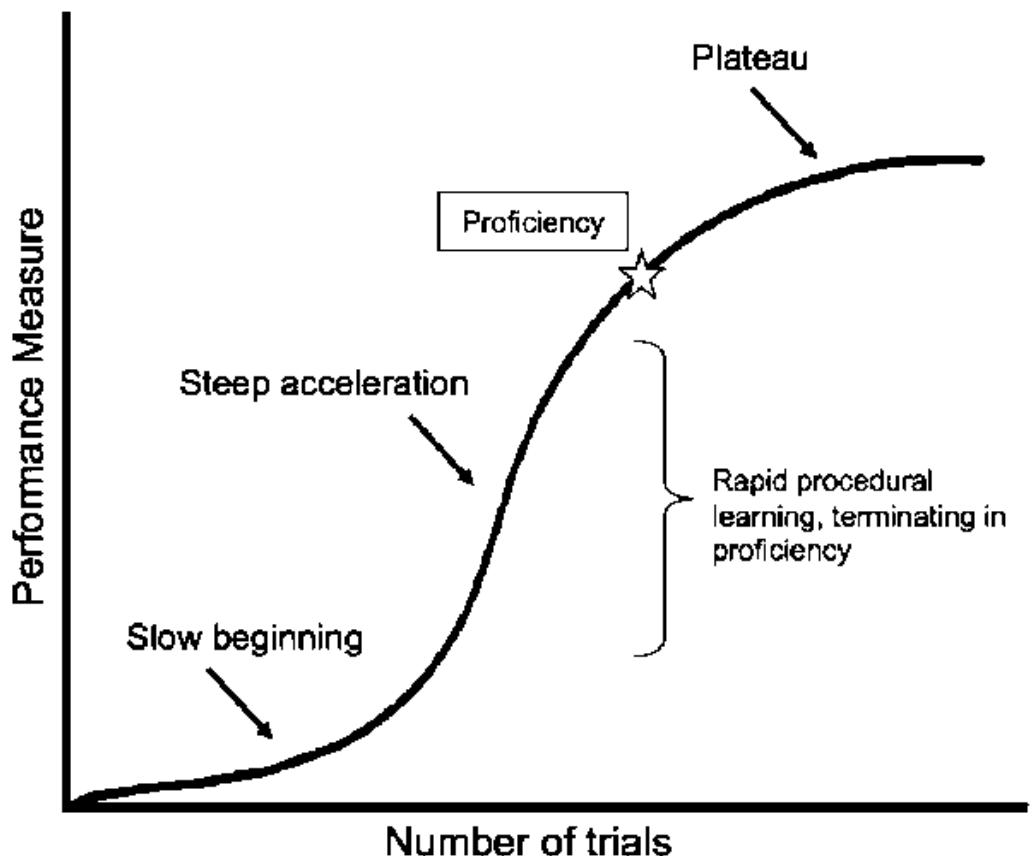
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Measure of each usability quality component

1. *Learnability:* Time to learn
2. *Efficiency:* Speed of performance
3. *Errors:* Rate of errors by users
4. *Memorability:* Retention over time
5. *Satisfaction:* Subjective satisfaction

# #1 Learnability: *Time to Learn*

How long does it take for typical members of the user community to learn how to use the actions relevant to a set of tasks?

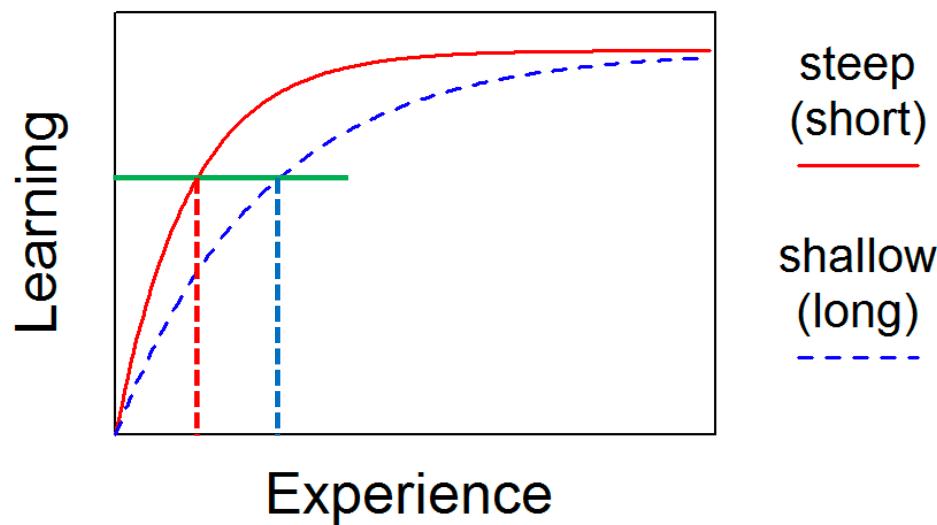


A typical [learning curve](#)

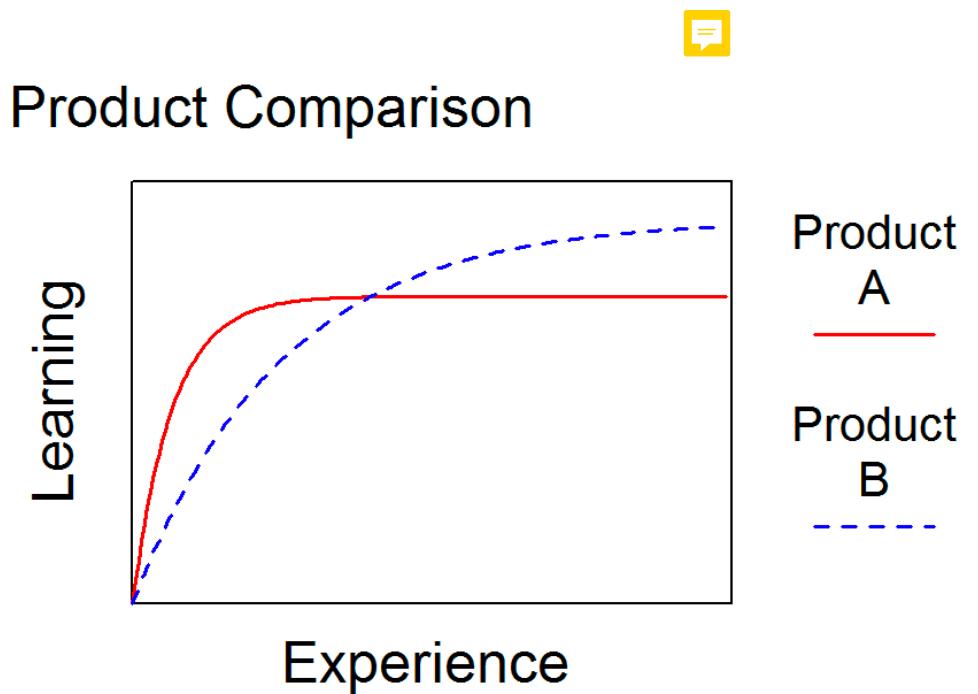
# #1 Learnability: *Time to Learn*

How long does it take for typical members of the user community to learn how to use the actions relevant to a set of tasks?

Steep and Shallow



Product Comparison



## #2 Efficiency: *Speed of Performance*

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How long does it take to carry out the benchmark tasks?

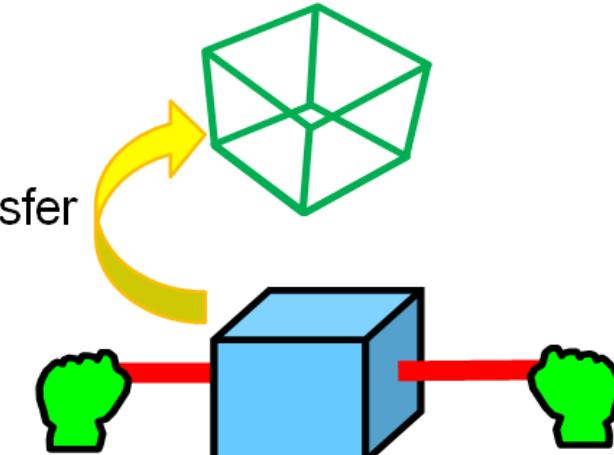
Square with random position appears  
after each successful pointing



A pointing task

Target position and orientation  
indicated by wire-frame envelope

Transfer



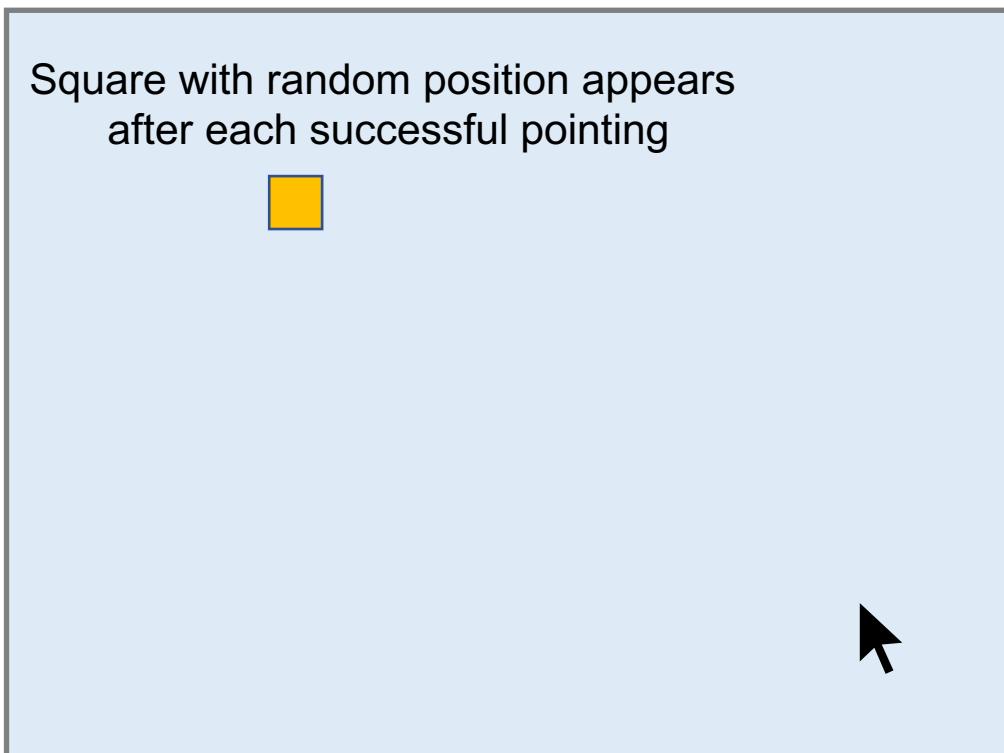
Cube with random orientation appears  
after each successful transfer

A 3D virtual object manipulation task

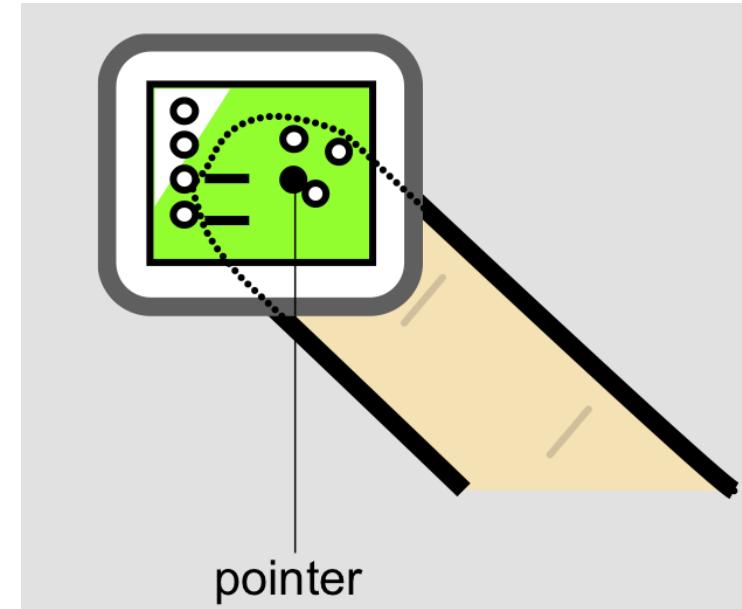
# #3 Errors: *Rate of Errors by Users*

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How many and what kinds of errors are made during benchmark tasks?



A pointing task



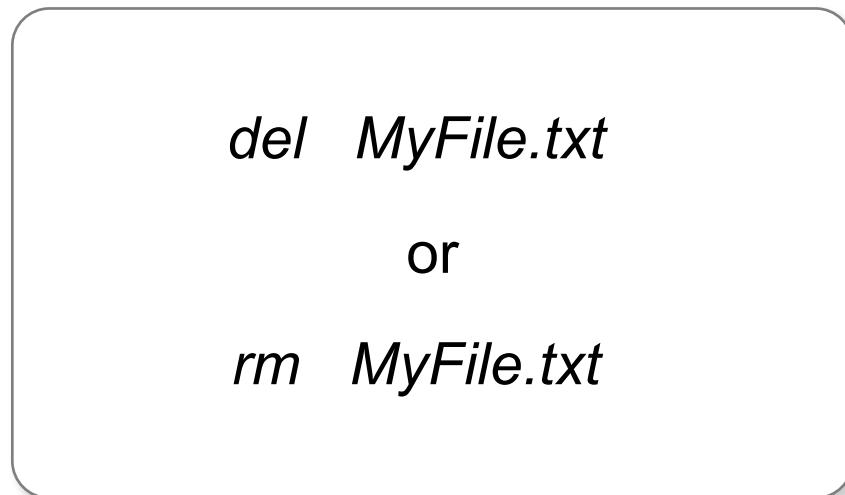
Fat finger problem of touch interface

# #4 Memorability: *Retention over Time*

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How well do users maintain their knowledge after an hour, a day or a week?

- Frequency of use and ease of learning help make for better user retention



Command line interface



Graphical user interface

# #5 Satisfaction: *Subjective Satisfaction*

How much did users like using various aspects of the interface?

- Allow for user feedback via satisfaction scales, free-form comments and interviews



Name \*

First  Last

Email \*

Your Experience \*

Overall, how would you rate your experience with us?

How satisfied are you with \*

	Very Unsatisfied	Unsatisfied	Neutral	Satisfied	Very Satisfied
Purchase	<input type="radio"/>				
Service	<input type="radio"/>				
Company Overall	<input type="radio"/>				

How likely are you to \*

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
Buy from us again	<input type="radio"/>				
Recommend our product to others	<input type="radio"/>				
Recommend our company to others	<input type="radio"/>				

Additional comments or suggestions

Submit

# Usability Measures

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- Every designer would like to succeed in every category, but there are often forced tradeoffs:
  - If lengthy learning is permitted, task-performance times may be reduced by use of macros or shortcuts.
  - If the rate of errors is to be kept extremely low, speed of performance may have to be sacrificed.
- Project managers and designers who are aware of the tradeoffs can be more effective in making their choices explicit and public.

# Usability Measurement

- One serious way to measure usability: **user study**, which is the evaluation of how a group of people use a certain user interface



# Usability Measurement

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- **Formal** user studies
  - a usability testing lab with professional equipment
  - staffs such as psychologists, technicians, and HCI specialists
  - a part of any serious large-scale UI development (e.g., Gmail)
- **Informal** user studies
  - No fancy lab or expensive equipment
  - A simple test plan and task list are prepared, notepad and pencil
  - Participants are observed by an impartial moderator
  - The advantage is that informal testing looks at what people actually do when they are doing real work in an ordinary setting

# Usability Measurement

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- 5-step process of user studies

1. Plan & prepare
2. Find participants
3. Conduct tests
4. Analyze results
5. Develop recommendations

# Usability Measurement

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- 5-step process of user studies

1. Plan & prepare

Develop a test plan; create a task list; settle down the equipment; print instructions or user manuals

2. Find participants

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# Usability Measurement

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- 5-step process of user studies

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Test outside the team; participants from diverse backgrounds

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# Usability Measurement

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Develop a test plan; create a task list; settle down the equipment; print

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Test outside the team; participants from diverse backgrounds

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## 5. Develop recommendations

Table 1. Summary of the user study participants

User	Gender	Age group	Navigation devices	Touch screen devices
U1	Male	36-45	Some experience	Has tried
U2	Female	26-35	Has tried	Some experience
U3	Female	46-	Quite regularly	Never
U4	Male	26-35	Never	Has tried
U5	Female	36-45	Some experience	Quite regularly
U6	Female	26-35	Never	Has tried
U7	Male	46-	Has tried	Some experience
U8	Female	36-45	Never	Has tried
U9	Female	46-	Some experience	Some experience
U10	Male	18-25	Some experience	Never
U11	Female	18-25	Never	Has tried
U12	Male	26-35	Quite regularly	Quite regularly
U13	Male	46-	Quite regularly	Quite regularly
U14	Male	18-25	Has tried	Has tried
U15	Male	36-45	Has tried	Some experience
U16	Female	26-35	Some experience	Quite regularly

# Usability Measurement

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- 5-step process of user studies

## 1. Plan & prepare

Develop a test plan; create a task list; settle down the equipment; print instructions or user manuals

## 2. Find participants

Test outside the team; participants from diverse backgrounds

## 3. Conduct tests

Explain the process to the user; user performs the tasks; take note and record statistics; post-test survey

## 4. Analyze results

## 5. Develop recommendations

# Usability Measurement

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## 4. Analyze results

Summarize recorded data into a table; analyze and visualize data; identify difficulties and problems

## 5. Develop recommendations

# Usability Measurement

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## 4. Analyze results

Summarize recorded data into a table; analyze and visualize data; identify difficulties and problems

## 5. Develop recommendations

Gather compiled information and translate into recommendations; write up a formal report

# Today's Topics

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- What is usability?
- Usability measures
- **Usability requirements**
- Usability motivations
- Universal usability

# Usability Requirements

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- The U.S. Military Standard for Human Engineering Design Criteria (1999) states the purposes when designing a UI:
  - Achieve required performance by operator, control, and maintenance personnel
  - Minimize skill and personnel requirements and training time
  - Achieve required reliability of personnel-equipment/software combinations
  - Foster design standardization within and among systems

# Usability Requirements

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Measurable usability requirements that the user interface has to satisfy

1. Ascertain the user's needs
2. Ensure proper reliability
3. Promote standardization
4. Promote consistency
5. Promote portability

# Requirement #1: *Ascertain Users' Needs*

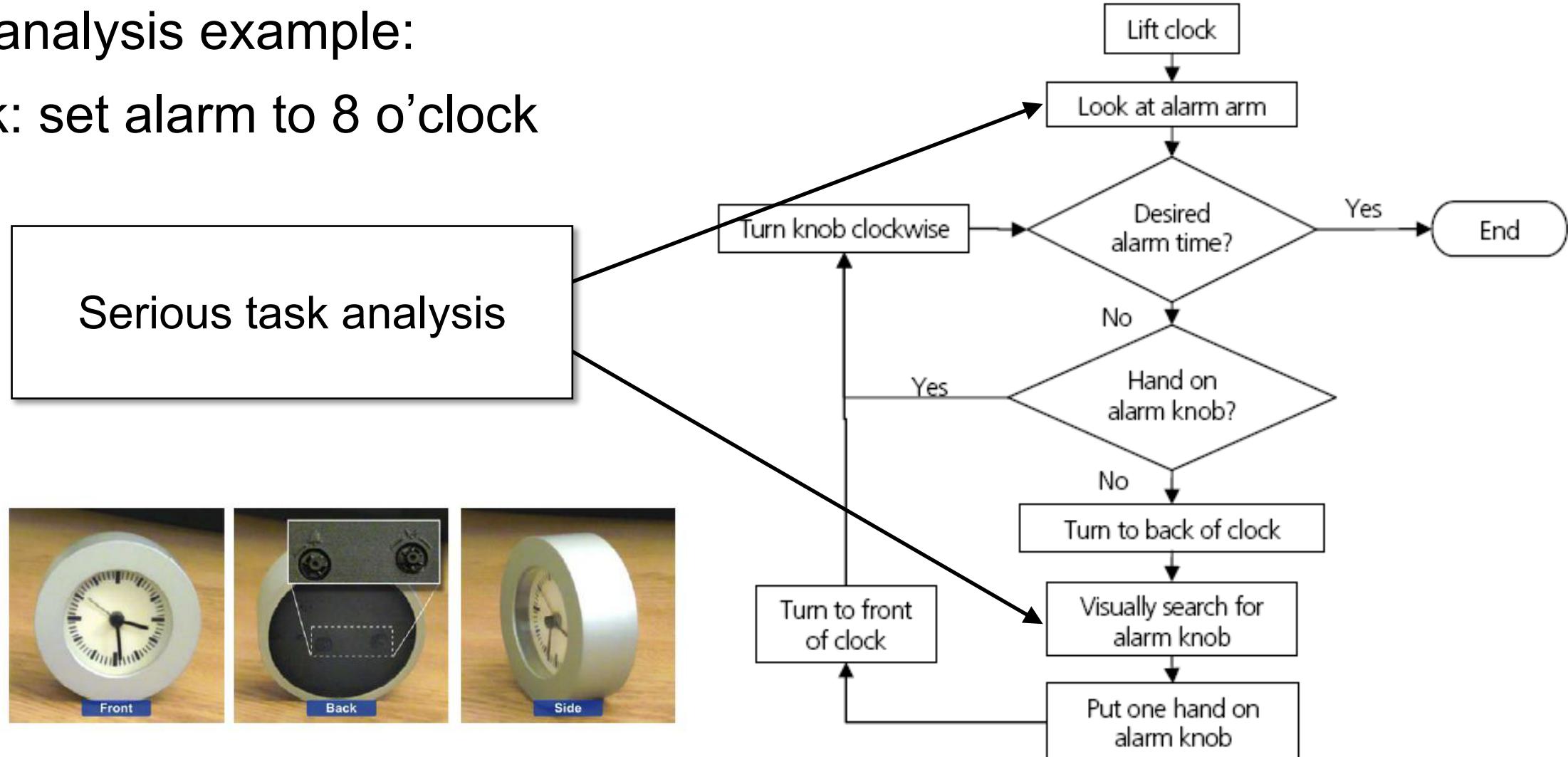
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- Determine what tasks and subtasks must be carried out
- Include all tasks
  - Common tasks are easy to identify
  - Occasional or exceptional tasks may not be obvious
- Functionality **must match need** or else users will reject or underutilize the interface
  - Inadequate functionality frustrate users – rejected!
  - Excessive, probably the more common mistake of designers, is also danger, because the **complexity** makes implementation, maintenance and learning more difficult.

# Requirement #1: Ascertain Users' Needs

- Task analysis example:
  - task: set alarm to 8 o'clock

Correct sequence of actions:



## Requirement #2: *Ensure Reliability*

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- Actions must function as specified
- The system must not introduce errors
- The system should be available as often as possible
  - No offline or long waits
- Ensure the user's privacy and data security by protecting against unwarranted
- Be sensitive to the user's sense of mistrust
  - Only a few errors and the user will not use your system
  - Users trust is *fragile*! This is even more true in real world market

# Requirement #3: *Promote Standardization*

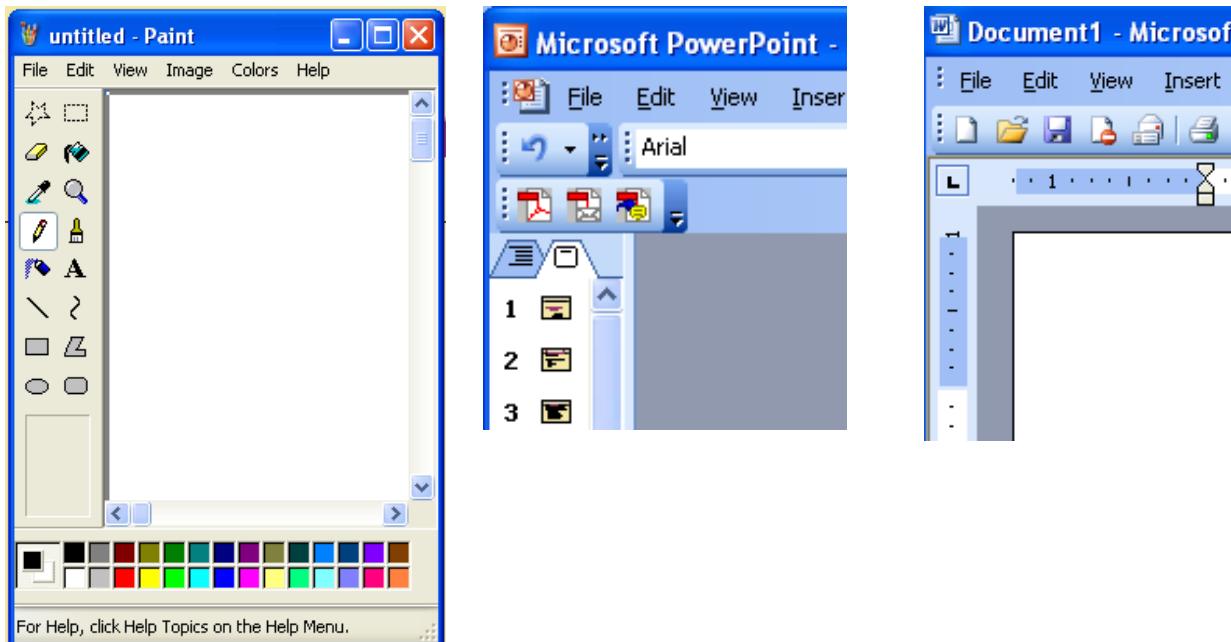
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- *Standardization*: use pre-existing industry standards where they exist to aid learning and avoid errors
  - **Slight differences** not only increase learning times but also lead to annoying and dangerous errors
  - **Gross differences** require substantial retraining and burden users, e.g. incompatible storage formats, software versions, etc. cause frustration, inefficiency and delay



# Requirement #4: Promote Consistency

- *Consistency:*
  - compatibility across different product versions
  - compatibility with related paper and other non-computer based systems
  - use common action sequences, terms, units, colors, etc. within the program

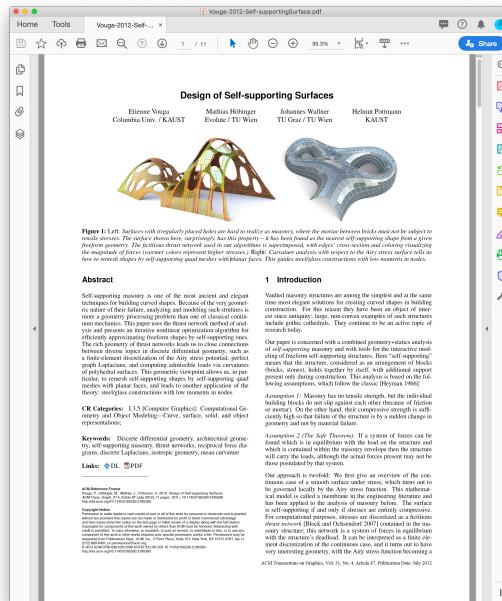


**Windows consistent menus:**

- File Edit View . . .
- Even for new applications you have never seen, users know where to go to load/save files, cut-and-paste, change view, etc.

# Requirement #5: Promote Portability

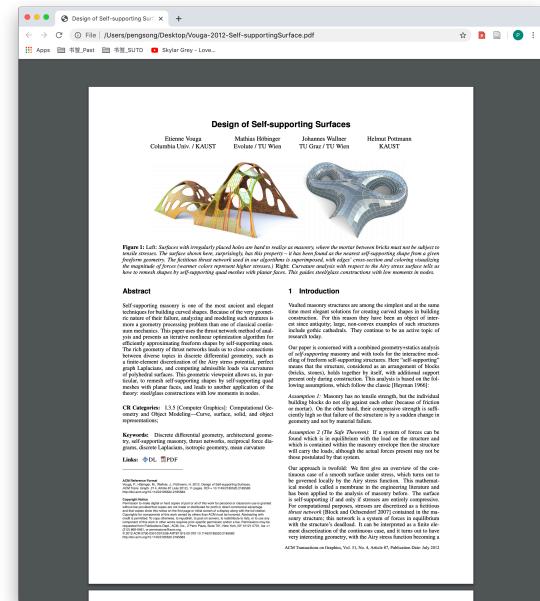
- *Portability:* allow for the user to convert data across multiple software and hardware environments
  - E.g. standard text files (in ASCII) can be moved easily across environments
  - UI building tools help by generating code for Mac, Windows, Unix, etc.



Adobe Acrobat



Apple Preview



Google Chrome

# Today's Topics

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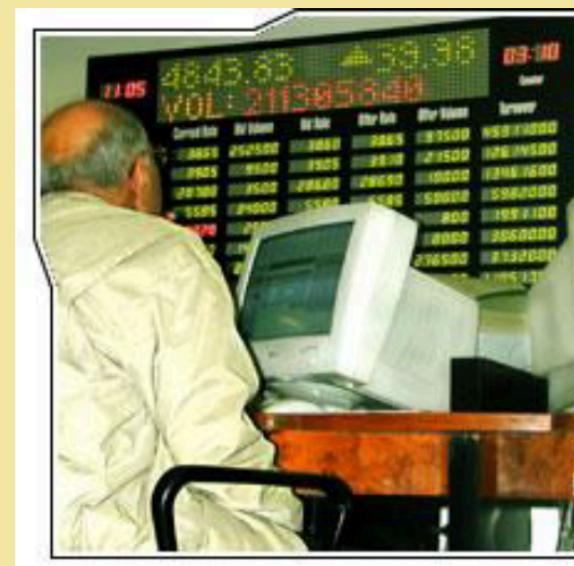
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# Usability Motivations

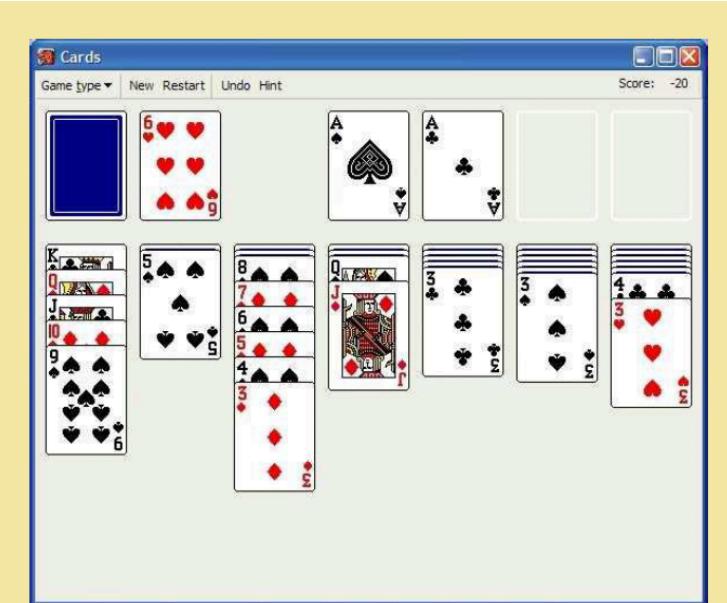
Different types of applications have different motivations and requirements for the user



Air-traffic Control



Stock-Trader



Card Game

# Application Types

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Classification by Ben Schneiderman:

- Life-Critical Systems
- Industrial and commercial uses
- Home and Entertainment
- Exploratory, creative, collaborative applications
- Social/Technological applications

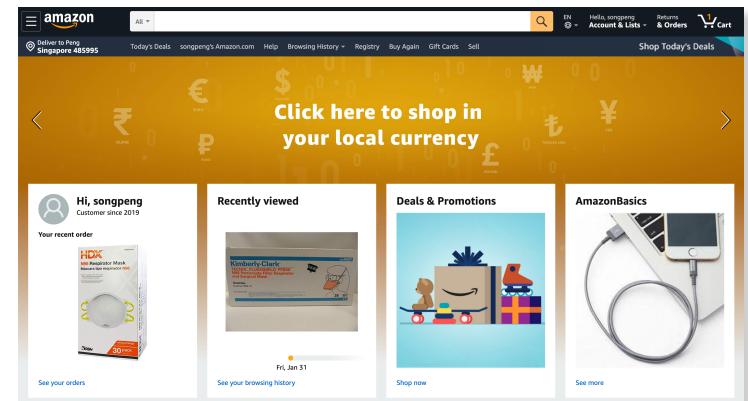
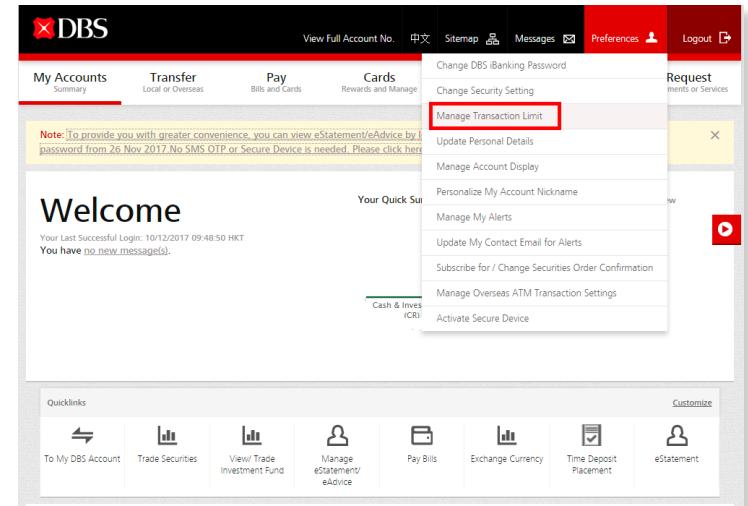
# Usability Motivations

- Life-critical systems
  - Applications:
    - Air traffic control, nuclear reactors, power utilities, police & fire dispatch systems, military operations, and clinical care
  - Requirements:
    - Reliability and effectiveness, error free performance
  - Not as important:
    - Cost, training time
    - user satisfaction



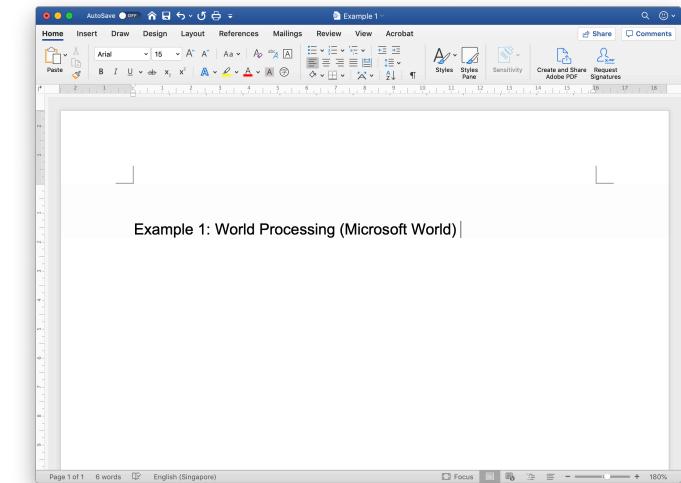
# Usability Motivations

- Industrial and commercial uses
  - Applications:
    - Banking, insurance, order entry, inventory management, reservation, billing system
  - Requirements:
    - Ease of learning is important to reduce training costs
    - Speed and error rates are relative to cost
    - Subjective satisfaction is fairly important to limit operator burnout
    - Speed of performance is important because of the number of transactions



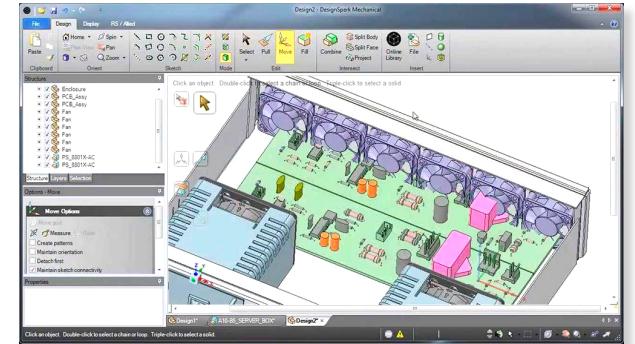
# Usability Motivations

- Office, home, and entertainment
  - Applications:
    - Word processing, electronic mail, computer conferencing, and video game systems, educational packages, search engines, mobile device, etc.
  - Requirements:
    - Choosing functionality is difficult because the population has a wide range of both novice and expert users
    - Infrequent use of some applications means interfaces must be intuitive and easy to use online help is important
    - Ease of learning, low error rates, and subjective satisfaction are paramount due to use is often discretionary and competition fierce
    - Market competition often forces the need for low cost



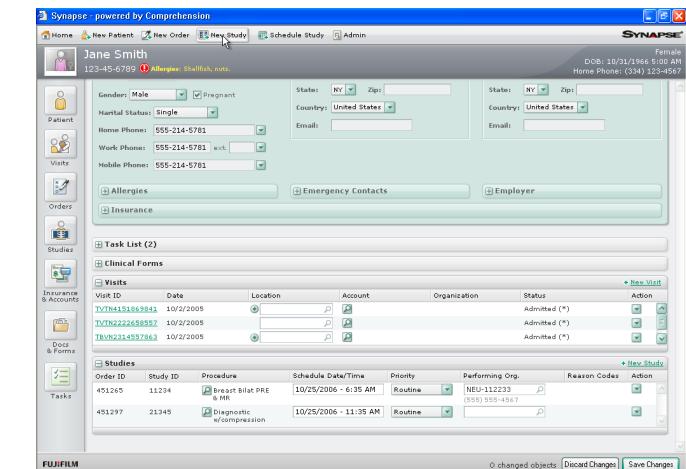
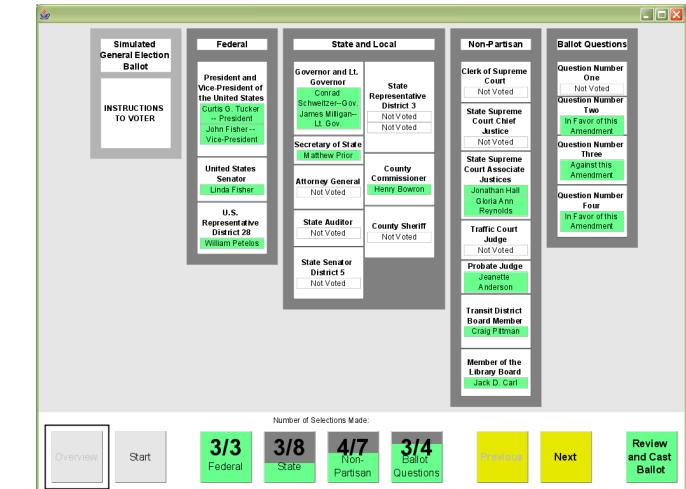
# Usability Motivations

- Exploratory, creative, and collaborative systems
  - Applications:
    - Web browsing, search engines, artist toolkits, architectural design, software development, music composition, and scientific modeling systems
  - Requirements:
    - Users may be knowledgeable in the task domain but novices in the underlying computer concepts, so
    - Remove the “Computer from the Work”
    - With these applications, the computer should “vanish” so that the user can be absorbed in their task domain



# Usability Motivations

- Social-technical systems
  - Applications:
    - Voting, healthcare, identity verification, disaster response, crime reporting
  - Requirements:
    - Trust, privacy, responsibility, and security are issues
    - Verifiable sources and status feedback are important
    - Ease of learning for novices and feedback to build trust
    - Administrators need tools to detect unusual patterns of usage
  - Difficulties:
    - Huge systems that evolve over time



# Today's Topics

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- **Universal usability**

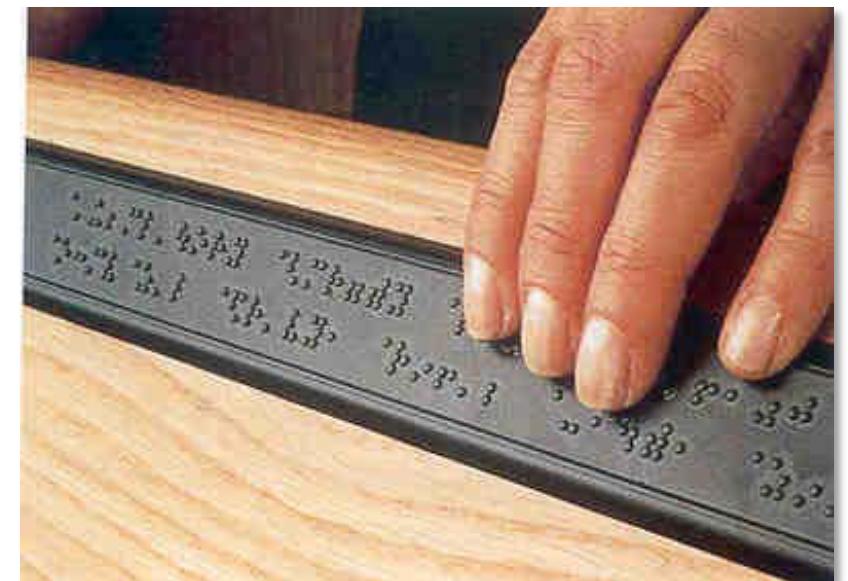
# Universal Usability

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- The design of products and environments to be **usable by all people**, to the greatest extent possible, without the need for adaptation or specialized design
- HCI pioneer Ben Shneiderman define it more concretely as  
*“having more than 90% of all households as successful users of information and communications services at least once a week.”*

# Universal Usability

- **Ultimate goal:** try to make interfaces as usable and enjoyable by everyone
- Not always possible...so may need **multiple interfaces** that cater to different people



# Universal Usability

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- Understanding the **difference among users** is vital for
  - expanding market share
  - supporting required government services
  - enabling creative participation by the broadest possible set of users

# Users are Diverse

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- Users are different in:

#1 Physical abilities

#2 Cognitive and perceptual abilities

#3 Personalities

#4 Culture

# Diversity #1: *Physical Abilities*

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- Basic data about human dimensions comes from research in *anthropometry*
  - Male/female, young/adult, European/Asian, tall/short
  - Head, mouth, nose, neck, shoulder, chest, arm, etc.
- There is “no average user”, either compromises to the UI must be made, or multiple versions of a system must be created
- Physical measurement of human dimensions are not enough, taken into account dynamic measures

# Diversity #2: *Cognitive and Perceptual Abilities*

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- The journal *Ergonomics Abstract* offers this classification of human cognitive processes:
  - Short-term and working memory
  - Long-term and semantic 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



## Diversity #2: *Cognitive and Perceptual Abilities*

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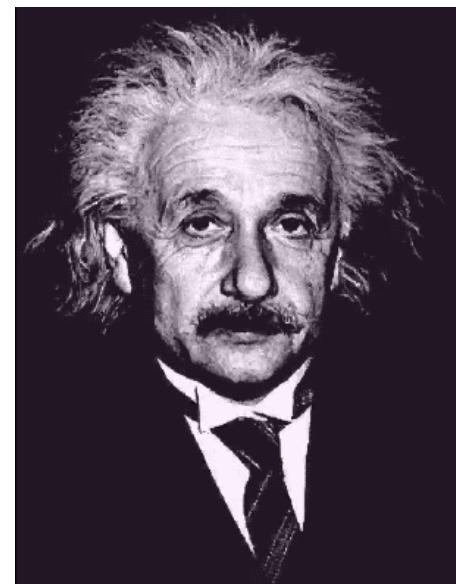
- They also suggest a set of factors affecting perceptual and motor performance, e.g.,
  - Arousal and vigilance
  - Fatigue and sleep deprivation
  - Perceptual (mental) load
  - Knowledge of results and feedback
  - Fear, anxiety, mood, and emotion
- But note, in any application, **background experience and knowledge** in the task domain and the interface domain play key roles in learning and performance

# Diversity #3: *Personality Differences*

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- 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
- Myers-Briggs Type Indicator (MBTI)
  - extroversion vs introversion
  - sensing vs intuition
  - perceptive vs judging
  - feeling vs thinking

[http://www.personalitiypathways.com/type\\_inventory.html](http://www.personalitiypathways.com/type_inventory.html)



# Diversity #4: *Cultural Differences*

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- **13** is unlucky in the West
  - Friday the 13<sup>th</sup>: [http://en.wikipedia.org/wiki/Friday\\_the\\_13th](http://en.wikipedia.org/wiki/Friday_the_13th)
- **4** is unlucky in Chinese
- Product Re-naming
  - Nissan Sunny (Asia)
  - Nissan Sentra (North America)
  - Nissan Tsuru (Mexico)



# Considerations for the Disabled

- Users with disabilities
  - Designers must plan early to accommodate users with disabilities, over half a billion in the world
  - Early planning is more cost-efficient than adding on later
    - E.g., addition of closed captions to television programs for deaf viewers



Mainland China  
(Sidewalk “stones”  
for blind people)

# Considerations for the Elderly

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- Reduced
  - Motor skills
  - Perception
  - Vision, hearing, touch, mobility
  - Speed
  - Memory
- Other needs
  - Technology experience is **varied** (How many grandmothers use email?)
  - Often **uninformed** on how technology could help them



(But don't underestimate elderly people)

# Considerations for the Elderly

- Example user interfaces for the elderly

The image displays two mobile devices: a smartphone on the left and a tablet on the right. The smartphone screen shows a grid-based interface titled 'MOBILE.OLD' with categories like 'EMERGENCY CALL', 'MOBILE. ACTIVITY', 'MOBILE. AID', 'MOBILE. CHECKLIST', 'MOBILE. COMPASS', and 'MOBILE. INSIGHT'. The tablet screen shows a more complex interface with a weather update ('75 °F Chicago, Illinois Overcast Clouds'), a greeting ('Good morning, Emma'), and various app icons and cards for 'Address Book', 'Measure Blood Pressure', 'Interests', 'Video Call Nurse', and 'Go to sleep'. Blue callout boxes on the smartphone highlight features: 'Large, adjustable fonts for readability' pointing to the text in the app; 'Always-accessible home button' pointing to the red home icon at the bottom; and 'Action buttons with standardized purpose' pointing to the 'Exit' and 'Settings' buttons.

Large, adjustable fonts for readability

Always-accessible home button

Action buttons with standardized purpose

Standardized Layout:

- Heading
- Content
- Action Bar

Contrast-rich color scheme

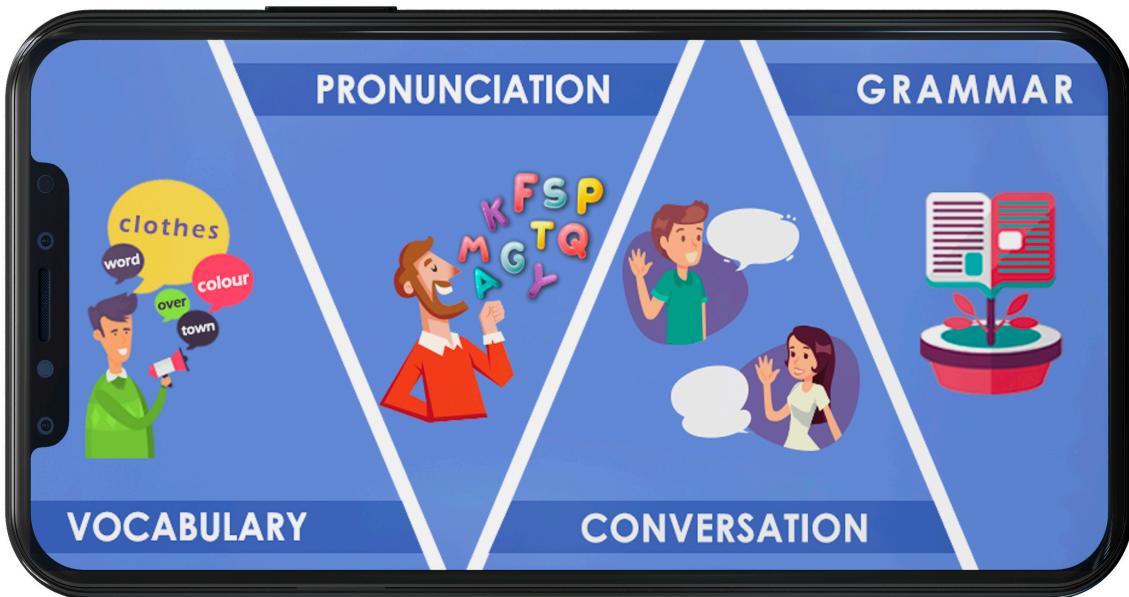
# Considerations for Children

- Emphasize entertainment and education
- Requires Safety – access to children
- They (children)
  - Like exploring (easy to reset state)
  - Don't mind making mistakes
  - Like familiar characters and repetition
  - Don't like patronizing comments, inappropriate humor

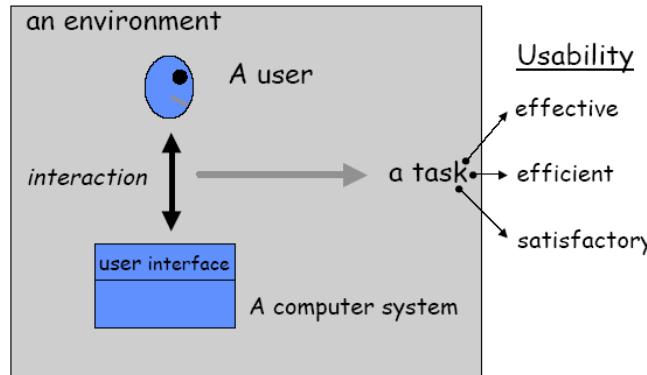


# Considerations for Children

- Example user interfaces for children



# Summary



Usability



Usability measures



Usability requirements



Usability motivations



Universal usability

# Coming Up

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## Next Monday: UI Design Process

- Instructed by *Leong Hwee Teo*
- 13:30 – 15:00 in 1.409 TT7 & 1.410 TT8