UNIVERSITY OF CRETE
FACULTY OF SCIENCES AND ENGINEERING
COMPUTER SCIENCE DEPARTMENT

COURSE CS-564 (OPTIONAL)

ADVANCED TOPICS

IN HUMAN – COMPUTER INTERACTION

Course Convenor: Constantine Stephanidis

DESIGN FOR ALL

Current challenges in the Information Society

- The Information Society has the potential to improve the quality of life of citizens, the efficiency of our social and economic organisation and to reinforce cohesion

But also,

- May lead to the creation of a two-tier society of “have” and “have-nots”, in which only a part of the population has access to the new technology, is comfortable using it and can fully enjoy the benefits
- There is a danger that ordinary citizens may reject the new information culture and its instruments

HCI and IST

- Acceptability of the emerging Information Society by all citizens ultimately depends on the accessibility and usability of the associated technologies
- HCI is one of the key factors towards ensuring social acceptability of computer-based products and services, as users experience new technologies through contact with their user interfaces
- In this context, HCI is continuously called upon to face new challenges

HCI *for* Universal Access

- ***Accessibility***

  For any individual user, for each user task, there is a sequence of accessible input actions and associated feedback for successful accomplishment

- ***Usability***

  For any individual user, for each user task, there is at least one path for optimal accomplishment

- Given the above
  - It is unrealistic to expect that a single interface design will ensure high-quality interaction for diverse user groups and contexts of use

Prevalent approaches to accessibility

- Accessibility refers to the extent to which the use of an application or service is affected by the user's particular functional limitations or abilities (permanent or temporary), as well as by other contextual factors (e.g., characteristics of the environment)
- Usually focuses on users with disabilities and their right to access interactive applications and services, mainly through **Assistive Technologies**
- In many countries it is regulated by law in specific circumstances (e.g., public procurement, work environment)

Brief history of accessibility

- Early adopters
  - architects
  - interior designers
- Application in landscape design
  - Public buildings
  - Workplaces
  - Housing
  - Public terminals

Human factors guidelines

- Location signs easy to read?
- Adequate lighting levels?
- Queuing arrangements?
- Clear path for wheelchairs?
- Level surface?
- Location system for blind?

Assistive Technologies (1/2)

- **Assistive or Adaptive Technology** commonly refers to *"...products, devices or equipment, whether acquired commercially, modified or customized, that are used to maintain, increase or improve the functional capabilities of individuals with disabilities..."*

Assistive Technology Act of 1998

Assistive Technologies (2/2)

- **Assistive technology** is a generic term that includes:
  - *assistive*, *adaptive*, and *rehabilitative* devices and the process used in selecting, locating, and using them
- AT promotes greater independence for people with disabilities by enabling them to perform tasks that they were formerly unable to accomplish, or had great difficulty accomplishing, by providing enhancements to or changed methods of interacting with the technology needed to accomplish such tasks

Wikipedia, http://en.wikipedia.org/wiki/Assistive_technology

Characteristics of the Operating System

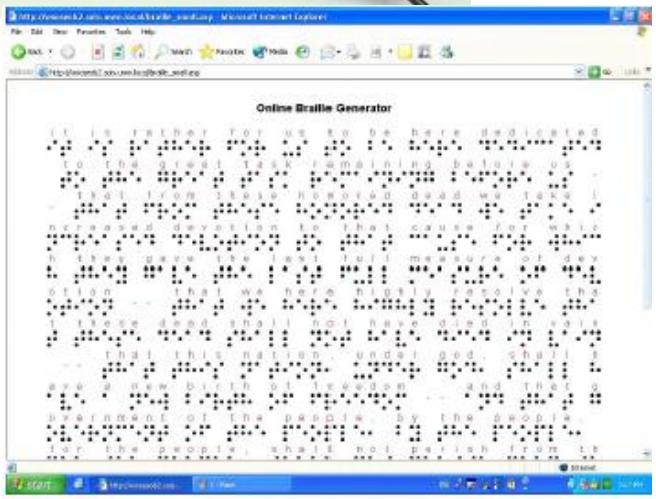
- Fonts
  - size, color
- Size of images
- Screen analysis
- Combination of colors
- Customisation of the pointer
- Customisation of sound
- FilterKeys
  - Prolongued pressing is ignored, speed of character repetition can be customized
- StickyKeys
  - In key combinations, keys are pressed in sequence and not all at the same time
- ToggleKeys
  - Pressing keys produces sounds
- MouseKeys
  - The mouse pointer moves using keys

Alternative devices

- Input
  - Alternative keyboards
    - Larger keys or keyboards, alternative layouts, one-hand use
    - Braille keyboards
  - Alternative pointing devices
    - Pointer control without hand, through ultrasound, infrared, eye movements, brain waves
  - Interaction through breath
    - Activation through inspiration and expiration
  - Mouth or head-mounted devices
  - Joysticks and Trackballs
  - Touchscreens
- Output
  - Braille printers
  - Refreshable Braille displays

Assistive Technologies – Alternative Input Devices

Assistive Technologies – Alternative Output Devices



Software

- Screen readers
- Screen magnifiers
- Voice synthesis
- Voice recognition
- Visual keyboards
- Scanning
- Augmentative and Alternative Communication
- Text prediction

Shortcomings (1/2)

- Reproducing, instead of redesigning
- Requires extensive configuration of physical interaction parameters
- Implementation barriers (e.g., cannot reproduce graphical images in a non-visual form)
- Design conflicts (e.g., reproducing drag & drop dialogues for blind users)
- No upward compatibility

Shortcomings (2/2)

- Despite progress, Assistive Technologies and dedicated design approaches have been criticized for their essentially reactive nature
- Traditional efforts to provide accessibility for users with disabilities were based on the product-level and environment-level adaptation of applications and services, originally developed for able-bodied users
- The need for more systematic and proactive approaches to the provision of accessibility has emerged, leading to the concepts of Universal Access and Design for All

Importance of HCI design

- The importance of user interface design methodologies, techniques and tools in the context of the development and evolution of the Information Society is widely recognised in the light of the profound impact that interactive technologies are progressively acquiring on everybody's life and activities, and of the difficulty in developing usable and attractive interactive services and products
- In the emerging Information Society Universal Access becomes predominantly an issue of design
  - explicit design focus to systematically address diversity, as opposed to afterthoughts or ad hoc approaches

HCI design

- Traditionally
  - Assumptions about:
    - average «typical» users
    - the device is typically a desktop PC
    - the context of use was the business environment
  - Methodological focus on:
    - productivity enhancement
    - how tasks should be carried out rather than how they are being carried out

The problem today

- The user is no longer a tractable element to be studied in a laboratory
- The device is no longer the traditional PC with a keyboard, mouse and a VDU
- The context of use is no longer bound to the business environment
- Furthermore:
  - Interaction remains complex and multi-faceted phenomenon
  - Its social dimension adds to the complexity

Universal Access Origins

- The origins of Universal Access are to be identified in:

1. Providing access to computer-based applications by users with disabilities
   - Which in turn originates from architects and interior designers providing accessibility in public buildings, workplaces, housing and public terminals
2. Human-centered approaches to Human-Computer Interaction
   - Focus on usability, placing the user at the center of design and development process (aka user-centered design)

UA: bridging accessibility and usability

- Universal Access provides a clear answer to the debate on the relationships between accessibility and usability
  - accessibility becomes a fundamental prerequisite of usability, intended as the capability of all supported paths towards task accomplishment to “maximally fit” individual users’ needs and requirements in the particular context and situation of use

Universal Access definition

- Universal Access: *accessibility* and *usability* (and, ultimately, *acceptability*) of Information Society Technologies by **anyone**, **anywhere**, **anytime** and **through any media and device**
- Universal Access embraces theoretical, methodological, and empirical research, of both technological and non-technological nature
- Addresses all ***dimensions of diversity*** in the Information Society

Accessibility versus Universal Access

- Shift from accessibility, as traditionally defined in the assistive technology sector, to universal access, due to:
  - developments in technology
  - increased social interest for people at risk of exclusion, including not only people with disabilities, but any person who may differ with respect to language, culture, computer literacy, etc.

User– centered design versus Universal Access

- Universal Access goes well beyond current approaches stating the centrality of the human element in the design and development process (Norman and Draper 1986)

- Introduces a new and challenging dimension:

  the consideration and valorization of human diversity

Dimensions of Diversity

- Diversity in HCI arises from
  - variety in the user population
  - variety in the nature of work
  - variety in the context of use
  - variety in technological platforms

User diversity factors (1/2)

- Disabilities and Impairments
  - Physical disabilities
  - Situationally-induced impairments
  - Sensory impairments
  - Learning disabilities and Developmental Disorders
- Skill Level
  - Novice users
  - Expert users
  - Designers
- Cognitive Factors
  - Memory
  - Intelligence

User diversity factors (2/2)

- Social Issues
  - Socio-economic factors
  - Globalization
- Cultural and Linguistic Issues
  - Language
  - Cultural Interpretations
- Age
  - Children (<18)
  - Older users (>65)
- Gender
  - Stereotypes
  - Societal issues

Further reading: A more detailed analysis of the user diversity factors is available in the lecture notes, which can be downloaded from the course website

Variety in the nature of work

- Business versus residential activities
- Collaborative tasks
- New virtualities which augment human capabilities for problem solving:
  - Digital libraries
  - Virtual cities
  - Virtual university
  - Electronic market places
  - Digital money
  - etc.

New realities and interaction environments

- The diffusion of the **Internet** and the proliferation of **advanced interaction technologies** signify that many applications and services are no longer limited to the visual desktop, but span over new realities and interaction environments.
- Context of use and technological platforms have become just as diverse as users

Variety in the context of use

- Laboratory
- Business
- Nomadic use
- Fixed-point access versus mobile access

Variety in platforms

- Plethora of platforms and access terminals:
  - Desktop PC
  - Mobile devices
  - Information kiosks
  - Personal assistants
  - Wearables
  - Network attachable devices

Universal Access challenges

- The development of the Information Society is **not likely** to be characterized by a linear technological progression, but rather through the often competing forces of innovation, competitive advantage, human nature and social resistance
- ‘Inclusion’ must be a process which is the result of the ‘human agency’ of the many diverse individuals and cultural or national groups who should help shape and determine, and not merely ‘access’, technological outcomes”

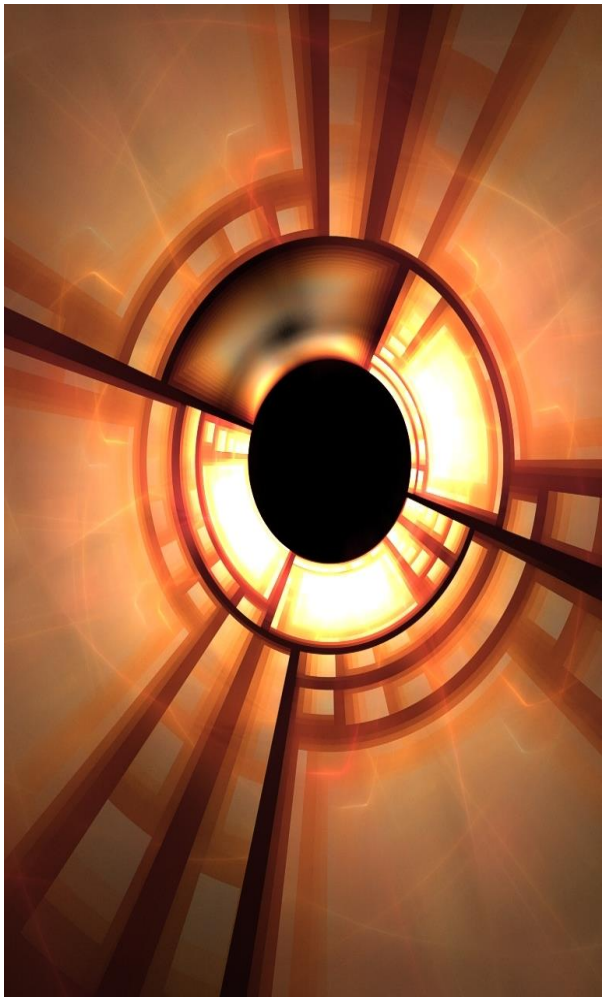
UA: Rising to the challenge

- At the scientific level, this amounts to a need of establishing **cross-discipline collaborative views**, based on **synergies** amongst relevant disciplines, in order to bring about a new conceptualization of computer-mediated human activities within the Information Society

Multidisciplinary nature

- The field of UA displays a conscious effort to ensure:
  - a broad scope of research and development activities
  - empowered with new concepts, tools and techniques
  - from **diverse** and in some cases **dispersed** scientific disciplines, technological strands, and socio-economic and policy perspectives

Focus on Design



- Universal Access has a focus on design, as it entails a forward-looking proactive attitude towards shaping new generations of technology, rather than short- or medium-term interventions on the present technological and market situation
- Innovation in design is invested with a central role, in terms of methodological frameworks, processes, techniques, tools and outcomes

Design for All synonyms

- **Design for All** (Europe) either subsumes, or is a synonym of, terms such as
- **accessible design**,
- **inclusive design**,
- **barrier-free design**,
- **universal design (USA)**,
- each highlighting different aspects of the concept

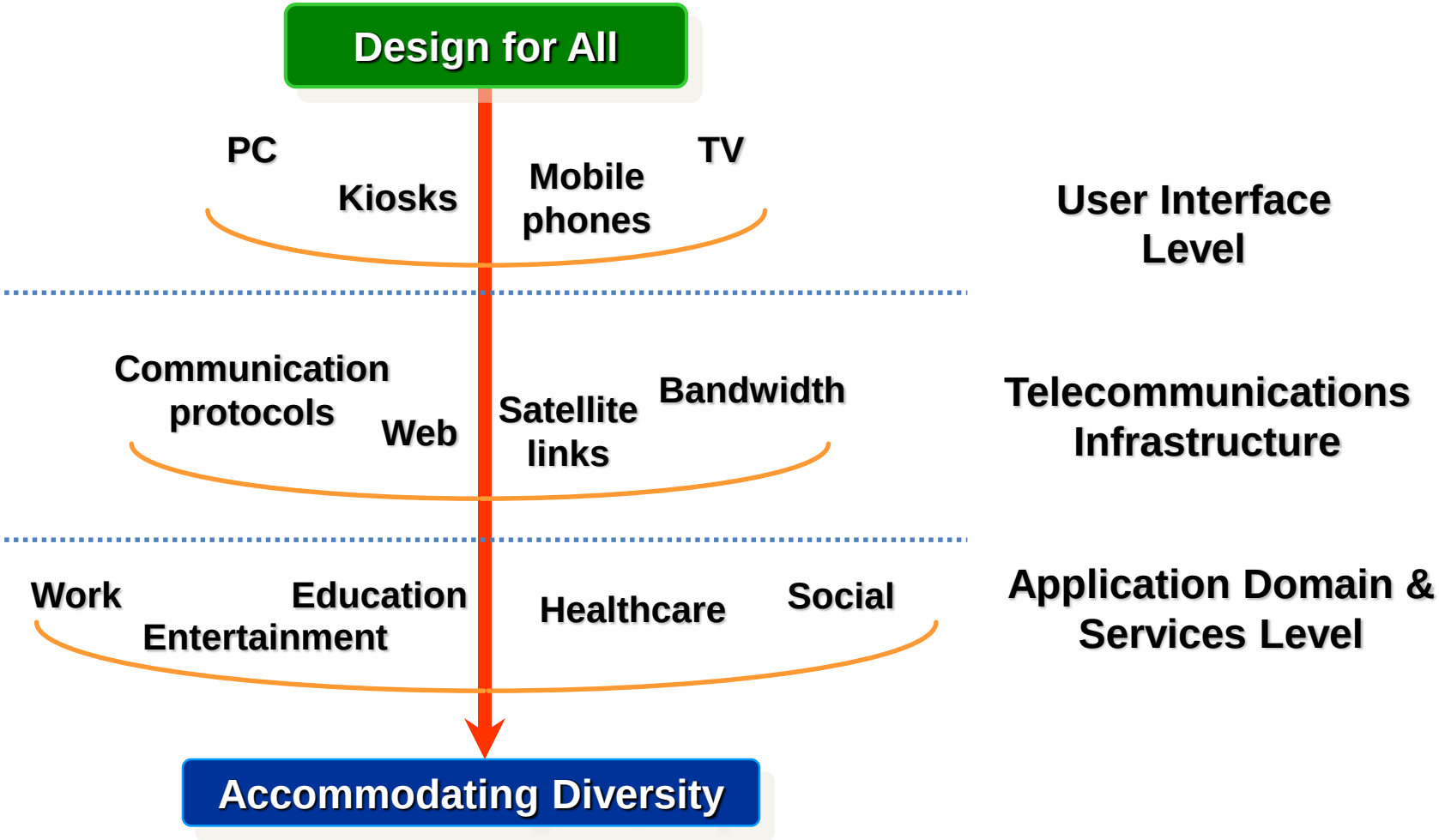
Design for All main connotations (1/2)

- Design of interactive products, services and applications
  - Suitable for most of the potential users without any modifications
  - Related efforts mainly aim to formulate accessibility guidelines and standards in the context of international collaborative initiatives
- Design of products which have standardized interfaces, capable of being accessed by specialized user interaction devices (e.g., Zimmermann, Vanderheiden, and Gilman 2002)
- **Design of products which are easily adaptable to different users by incorporating adaptable or customizable user interfaces** (Stephanidis 2001)

Design for All main connotations (2/2)

- The latter approach fosters a conscious and systematic effort to **proactively** apply principles and methods, and employ appropriate tools, in order to develop interactive products and services which are accessible and usable by all citizens in the Information Society, thus avoiding the need for a posteriori adaptations, or specialized design
- This entails an effort to build access features into a product starting from its conception, throughout the entire development life-cycle

Design for All: levels of concern



Principles of Design for All

“Copyright © 1997 NC, State University, The Center for Universal Design.”

1. Equitable use

The design is useful and marketable to people with diverse abilities

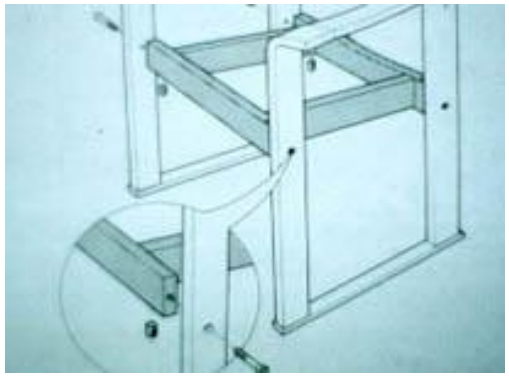
- Guidelines
  - Provide the same means of use for all users: identical whenever possible; equivalent when not
  - Avoid segregating or stigmatizing any users
  - Provisions for privacy, security, and safety should be equally available to all users
  - Make the design appealing to all users

2. Flexibility in use

The design accommodates a wide range of individual preferences and abilities

- Guidelines
  - Provide choice in methods of use
  - Accommodate right- or left handed access and use
  - Facilitate the user's accuracy and precision
  - Provide adaptability to the user's pace

3. Simple and intuitive



Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level

- Guidelines
  - Eliminate unnecessary complexity
  - Be consistent with user expectations and intuition
  - Accommodate a wide range of literacy and language skills
  - Arrange information consistent with its importance
  - Provide effective prompting and feedback during and after task completion

4. Perceptible information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities

- Guidelines
  - Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information
  - Provide adequate contrast between essential information and its surroundings
  - Maximize "legibility" of essential information
  - Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions)
  - Provide compatibility with a variety of techniques or devices used by people with sensory limitations

5. Tolerance for error

The design minimizes hazards and the adverse consequences of accidental or unintended actions

- Guidelines
  - Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded
  - Provide warnings of hazards and errors
  - Provide fail safe features
  - Discourage unconscious action in tasks that require vigilance

6. Low physical effort

The design can be used efficiently and comfortably and with a minimum of fatigue

- Guidelines
  - Allow user to maintain a neutral body position
  - Use reasonable operating forces
  - Minimize repetitive actions
  - Minimize sustained physical effort

7. Size and space for approach and use

Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility

- Guidelines
  - Provide a clear line of sight to important elements for any seated or standing user
  - Make reach to all components comfortable for any seated or standing user
  - Accommodate variations in hand and grip size
  - Provide adequate space for the use of assistive devices or personal assistance

Everybody, everywhere, anytime (1/2)

- It is difficult to use a keyboard when walking
- It is difficult and dangerous to use visual displays when driving a car
- Speech input and output, which work great in a car, may not be usable in a shared environment, in a noisy mall, in the midst of a meeting, or while in the library

Everybody, everywhere, anytime (2/2)

- When we create interfaces that will work well in noisy environments such as prop airplanes, construction sites, or shopping malls at holiday time, or for people who have to be listening to something else while they use their device, we will have created interfaces that work well for people who cannot hear
- When we create interfaces that will work well for people who are driving a car or doing something else, where it is not safe to look at the device, we will have created interfaces that can be used by people who cannot see
- When we create interfaces that can be used by people doing something that occupy their hands, we will have systems that can be used by people who do not have use of their hands
- When we create interfaces for individuals who are very tired, under a lot of stress, under the influence of drugs (legal or illegal), or in the midst of a traumatic event or emergency, and have little ability to concentrate or deal with complexity, we will have interfaces that can be used by people who have naturally reduced abilities to concentrate or deal with complexity

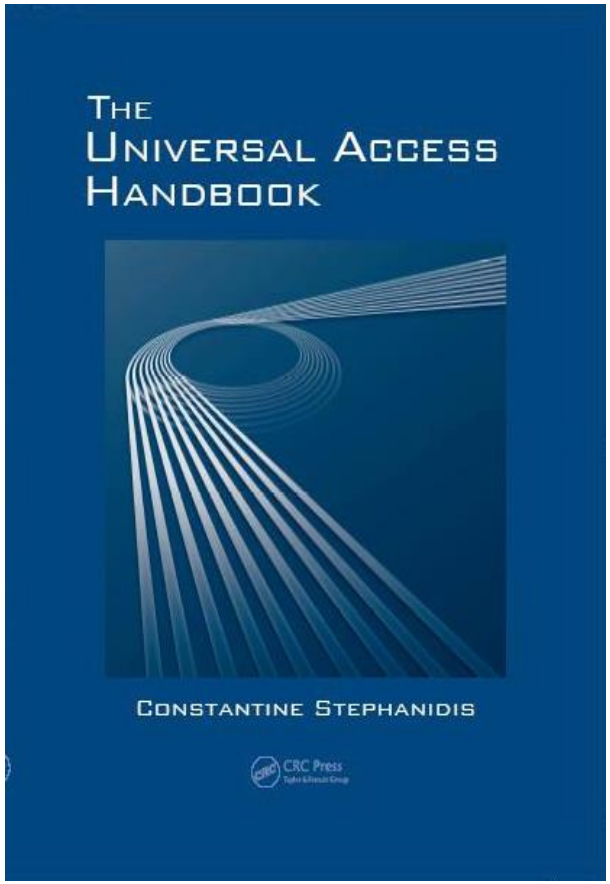
The research question

- Understanding the user and the context
  - Ethnographically-inspired inquiries
  - Scenarios
- Modelling the user and the context
  - User modelling techniques
  - Context modelling
- Accounting for diversity
  - Adaptable and adaptive interaction
  - Adaptation rationale (logic)

Conclusions

- The Information Society necessitates Universal Access
- Universal Access requires Design for All
  - Design for diversity in user and context of use
  - Multidisciplinary
  - Proactive, focus on design throughout the development life-cycle
- Appropriate methods and tools are required for Design for All
  - Design process and phases
  - Design techniques
  - Tools

References



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