Module -5
Contexts for Designing UX

SYLLABUS
Designing apps and websites – Website and app development, The information architecture of apps and websites. Social media -Social Networking, Sharing with others. Collaborative environments- Issues for cooperative working, Technologies to support cooperative working, AI and Interface Agents, Ubiquitous computing -Blended Spaces. Mobile Computing – Designing for Mobiles. Wearable Computing- Smart Materials, Material Design.

DESIGNING APPS AND WEBSITES- WEBSITE AND APP DEVELOPMENT

Designing and developing apps and websites are key aspects of human-computer interaction and interaction design, focusing on creating effective and enjoyable user experiences.

Website Design and Development

Websites serve as ubiquitous platforms for information access, services, content, and resources, used for World Wide Web browsing, search engines, and exploratory applications. Initially, website interface design primarily focused on navigation and presenting information or content. More recently, a dual focus has emerged with the design of web applications. While both web page design (content-focused) and web application design (application-focused) share similarities like being heavily graphical and information-rich, they also have significant differences.

- **Web Page Design:** Largely about balancing the structure and relationships of menus, content, and other linked documents or graphics to build a natural, well-structured, easy-to-use, and truthful hierarchy. It's a navigation environment where users frequently move between pages of information. Graphical design, including color, layout, composition, texture, typography, and imagery, is critical for aesthetics and usability. Using familiar terminology, recognizable visual elements, and organizing them meaningfully helps users navigate complex information structures.
- **Web Application Design:** Usually designed to collect and process data. Applications typically consume most or all of a screen and can monopolize user attention for long periods. The Web is considered a type of Graphical User Interface (GUI), and in building a web application, principles for selecting, presenting, and organizing GUI controls should be followed.

The distinction between web page and web application design can be seen as a continuum, depending on the design's intent, user expectations, activities, and program objectives. The merging of graphical business systems and the Web has led to intranets (internal company web systems) and extranets (intranets accessible externally).

Challenges and Considerations in Website Design:

Designers face challenges due to the wide range of user devices (handheld to high-end workstations) and varying connection speeds. This means the exact layout specified may not look the same to all users, as it's influenced by their hardware and software. Responsive design is a key approach to address this hardware diversity, enabling access from various display sizes by adapting content and layout. Responsive web design principles include mobile-first design, unobtrusive dynamic behavior (not wholly dependent on JavaScript), and progressive enhancement.

Other considerations include being sensitive to accessibility issues and potential distraction from animations and auto-play videos. Slow-to-load pages, often due to large graphics or animations, can be aggravating; minimizing bytes per page helps facilitate fast loading. Designers can use modern web technologies like HTML5 and CSS for smooth animations and sleek graphics. Modern web development utilizes languages like JavaScript, HTML, CSS, PHP, Ruby, and Java, with tools and libraries like React, Bootstrap, and WordPress. Concepts like Single-Page Applications (SPA) offer fluid, uninterrupted user experiences compared to Multi-Page Applications (MPA).

Numerous guidelines documents exist for web design. Examples include guidance from Apple, Android, and Microsoft on designing icons. Navigation principles like "Where am I? What's here? Where can I go?" are helpful guidance for designing web pages.

App Design and Development

Apps, particularly mobile apps, have driven a profound transformation, turning personal computers into successful mobile devices and enabling communication and collaboration. Desktop applications have increasingly given way to powerful social tools and apps for various purposes, including business, communication, medical advice, and creating user-generated content.

Mobile app development is a "hot topic" with international competition. The field of interaction design has expanded significantly, moving from primarily designing software applications for the desktop to addressing the explosion of new technologies like mobile and ubiquitous computing. Designers needed to rethink design for touchscreen devices like tablets and smartphones, as the standard desktop interface did not translate well. Touchscreen interaction styles involve tapping, swiping, and pinching, different from using a mouse or trackpad.

Key Aspects of App Design:

High-quality interfaces provide a competitive advantage. For mobile devices, which are often used for brief, routine tasks, it is critical to optimize designs for these repetitive actions while hiding less important functions. Reducing data entry and offloading complex tasks to the desktop is recommended. Designing for one-handed use, common with mobile devices, involves placing targets close together, configuring for left- or right-handed use, and centering targets. Selecting options rather than typing has benefits for both novice and frequent users. Simple gestures can trigger actions. Designing mobile-first interfaces that are responsive to varying devices is increasingly important.

Development Platforms and Tools for Apps:

Building mobile apps typically requires using Software Development Kits (SDKs) provided by the operating system manufacturer, such as the Android SDK (Java), Apple iOS SDK (Objective-C), and

Windows Phone/Mobile SDKs. These SDKs often include emulators for testing. Cross-platform mobile apps can also be built using web technologies, running in a dedicated browser instance. For dedicated personal computer applications, native SDKs like Microsoft's Visual Basic/C++ or Oracle's Java Development Kit (JDK) can be used.

Design tools beyond basic drawing applications are used for prototyping, including software like Visual Basic or Director, or web authoring tools. Tools like Adobe InDesign, Photoshop, or Illustrator can be used for design mockups. More advanced tools like Unity are available for creating 3D virtual environments. Physical computing tools like Arduino are used for building hardware prototypes. SDKs and APIs are fundamental components for app development.

Industry provides design case studies and detailed guidelines for mobile devices, such as those for Android or iPhone, which can be seen as "micro-HCI theories". App icons are designed to be visually attractive, informative, inviting, emotionally appealing, memorable, and distinctive.

General Design and Development Process

Designing interactive products like apps and websites is a deliberate process. Interaction design applies these ideas to digital artifacts and is considered a design discipline at its core. There are no intrinsic "laws," but rather guidelines, rules of thumb, and best practices.

The process is iterative, involving repeated design-evaluation-redesign cycles, often with users. Prototyping is crucial in facilitating this process. The design activity involves two main parts:

- **Conceptual Design:** Developing a conceptual model that outlines what the product will do and how it will behave, and the concepts users need to understand to interact with it.
- **Concrete Design (Physical Design):** Focusing on the details such as screen layout, menus, icons, graphics, colors, sounds, and images.

The Design Council of the UK's double-diamond model outlines four phases: Discover (gather insights), Define (frame the challenge), Develop (create, prototype, test, iterate solutions), and Deliver (finalize and launch). Key activities within this process include discovering requirements, designing alternatives, building prototypes, and evaluating them. These activities are intertwined.

A user-centered approach is vital, meaning users' concerns should direct the development. Understanding the diverse abilities, backgrounds, motivations, personalities, cultures, and work styles of users is challenging but essential for successful design. Designing for cultural and international diversity requires considering internationalization.

Effective app and website design requires contributions from various fields, including computer science, engineering, information science, business, psychology, sociology, education, and communications. Employers are increasingly hiring specialized roles such as user-interface designers, information architects, user experience designers, and usability testers, recognizing the competitive advantage of high-quality interfaces. Goals for the profession include providing necessary tools, techniques, and knowledge to commercial designers. Designers draw on their experience and inspiration from others' creations.

Evaluation methods applicable to both apps and websites include usability testing, user evaluation, expert reviews, predictive models, and analytics (like web analytics). A/B testing is specifically useful for evaluating the impact of design changes on websites and social media sites.

INFORMATION ARCHITECTURE OF APPS AND WEBSITES

The information architecture of apps and websites is fundamentally concerned with the structure, organization, and navigation of content and functionality to support user interaction and understanding. While the core principles of organizing information for user access apply to both, there are distinctions, particularly between content-focused websites and application-focused designs.

Information Architecture of Websites:

Websites are often viewed as ubiquitous platforms for information access. Initially, **website interface design primarily focused on navigation and presenting information or content**. Design effort was significantly concerned with the **information architecture**, specifically **how best to structure information at the interface level to enable users to navigate and access it easily and quickly**.

Key aspects of website information architecture include:

- **Structure, Navigation, and Information Content:** Websites generally vary in these three dimensions. **Structure issues** include **how the information is organized**, the **number of pages** it contains, and the **length of its pages**. **Navigation issues** revolve around **how the user moves around the site**, including the methods used and the support the site provides. **Information content issues** are **what information is included**, how much, and how it is presented.
- **Hierarchy and Relationships:** Web page interface design is largely a matter of properly balancing the **structure and relationships of menus, content, and other linked documents or graphics**. The design goal is to build a **hierarchy of menus and pages that feels natural, is well-structured, easy to use, and truthful**.
- **Navigation as Key to Success:** Web designers have emphasized **information-architecture theories with navigation as the keys to user success**. Users are sometimes considered as "foraging for information," and the effectiveness of the "information scent" of links is important; a good link gives a clear indication of the destination relative to the user's task. The challenge is designing large websites so users can find their way successfully, even through multiple clicks. Helpful guidance for designing webpages includes the questions: "**Where am I? What's here? Where can I go?**".
- **Content Organization:** Meaningful grouping and sequencing of choices, along with careful editing of titles and labels and appropriate layout design, can lead to easier-to-learn menus and increased navigation speed. Webpages act as **large menus where items are the embedded links or buttons** used to navigate to another page.
- **Web Pages vs. Web Applications:** A distinction exists between web page design (content-focused navigation) and web application design (application-focused data processing). While both are graphical and information-rich, a web page's intent is mostly to **provide information**, serving as a navigation environment where users move frequently

between pages. A web application is usually designed to **collect and process data**, consuming most of the screen and potentially monopolizing user attention. This distinction is a continuum based on design intent, user expectations, and objectives.
- **Intranets and Extranets:** These internal or externally-accessible web systems for organizations represent a merging of graphical business systems and the Web. Intranets are used for everyday activities and complex transactions, containing detailed and often massive amounts of information (10-100 times larger than public sites). The controlled environment of intranets allows for standardization and faster speeds, supporting rich graphics.
- **Dealing with Data Types:** Information systems, including web applications, often handle data sets with various structures such as hierarchies (like file trees) and networks (like hypertext structures). Organizing and laying out Web screens should encourage quick and accurate information comprehension.

Information Architecture of Apps:

While the term "information architecture" is applied more directly to websites in the sources, the principles of structuring and organizing content for user interaction are equally critical for app design, especially mobile apps.

Key aspects related to app information architecture include:

- **Structure and Layout:** Screen design and layout are complex areas involving psychological understanding and graphical design. A single screen often needs to present information clearly and act as the locus for interaction.
- **Content Organization:** Principles for content organization, developed in the context of traditional menus for desktop applications, are mostly useful for phone application designs. Organizing and laying out graphical screens encourages quick and accurate information comprehension and control execution. This includes meaningful grouping, sequencing, alignment, and balance.
- **Optimizing for Tasks and Devices:** Mobile apps are often used for brief, routine tasks, requiring designs optimized for repetitive actions while hiding less important functions [Introduction summary]. Reducing data entry and offloading complex tasks is recommended. Designing for one-handed use is a consideration.
- **Adapting to Interaction Styles:** Rethinking design for touchscreen devices like tablets and smartphones was necessary, as standard desktop interfaces didn't translate well. Touchscreen interaction involves tapping, swiping, and pinching. Simple gestures can trigger actions.
- **Responsive Design:** Designing mobile-first interfaces that are responsive to varying devices is increasingly important.

In essence, the information architecture for both apps and websites involves creating a logical, well-structured system for users to access, understand, and interact with information and functionality, guided by principles of usability, navigation, and content organization. Designers must consider the specific context, user goals, device capabilities, and the nature of the content (information vs. application/data) to create an effective architecture.

SOCIAL MEDIA- SOCIAL NETWORKING, SHARING WITH OTHERS

The concepts of **social media**, **social networking**, and **sharing with others** are deeply interconnected and represent significant shifts in how people communicate, collaborate, and interact using technology.

Social Media and Social Networking:

- There has been **explosive growth** in both social networking and user-generated content.
- Older media like newspapers and television have seen their audiences turn towards **social media platforms** such as **Facebook, Twitter, YouTube, and Wikipedia**, which are among the top 10 most visited services. These are accessible through web-based applications and small mobile devices.
- **Social media** is considered an indicator of larger future changes. It **enables the sharing of user-generated content**, particularly from mobile devices. While widespread, further work is needed to improve the quality of content produced, enable effective annotations, make materials accessible, and facilitate reuse in ways that protect users' privacy or potential for profit.
- Users actively **participate in social media applications**, such as Facebook, posting tweets and restaurant reviews, or editing Wikipedia pages.
- Twitter, originally a microblogging platform for short messages, has evolved into a "publish and subscribe" **social network** used for sharing information, finding experts, disseminating breaking news, coordinating disaster responses, and maintaining awareness. It has reshaped news dissemination from a traditional gatekeeping model to one where **social activity, personal connections, and algorithmic ranking** are highly important.
- Facebook is highlighted as another major **social network site**, with a vast number of global users who log in monthly. It changes the information consumption landscape and offers **substantial benefits for individuals' relationships**, helping people keep up with friends and solidify acquaintances. Facebook has been shown to help people **build social capital**.
- Beyond Facebook and Twitter, other **social network sites and chat platforms** are prevalent globally, enabling users to **easily and cheaply maintain connections and crystallize relationships**.
- The almost universal adoption of **social media** has connected most people in multiple ways across time and space, fundamentally changing how they make contact, stay in touch, connect, and maintain their social networks and family ties.
- **Social media** has significantly transformed how people keep in touch and manage their social lives.
- The academic field that emerged to study technology used by multiple people is Computer-Supported Cooperative Work (CSCW), but "social computing" is now an umbrella term that includes not just collaboration and work, but also cooperation, competition, and non-work activities like gaming and romance.
- The increased power of **social media and collaboration technologies** at a societal level impacts collective action, policy engagement, and potentially governance, but also introduces dangers from extreme groups. This necessitates a new balance of legal protections, police powers, and privacy.

- Sociologists, anthropologists, policymakers, and managers study how **social media** is changing various aspects of life, including education, family life, shopping, services, political organizations, and even raising questions about preserving personal trust and organizational loyalty as interactions shift from face-to-face to screen-to-screen. They also consider the challenges of conveying empathy and enhancing civic participation in this context.

Sharing with Others:

- The ease of information flow provided by the World Wide Web greatly facilitates **sharing**.
- Mobile devices have expanded capabilities for communication through voice, text messages, digital photos, and videos, enabling various forms of **sharing**.
- Specific actions associated with user interfaces can be tied to **sharing**, such as capturing information or photos left by others and **sharing** yours with future visitors.
- Online directories can facilitate creating group lists, making it easy to reach large groups, which supports **sharing** information broadly.
- Platforms like blogs and wikis embody a democratic philosophy of the web, allowing individuals to make their opinions widely available. Blogs allow creators to tell stories and readers to contribute comments, add pictures, and provide links. Wikis are collaborative web pages open for anyone to add or revise content (unless password protected). They are popular for project teams to discuss ideas, plan meetings, and develop agendas. Wikipedia is presented as a powerful example of **collaboration and sharing** on a massive scale.
- Online magazines, newsletters, and journals also serve as formats for **social discussion and sharing** of information and opinions.
- Online communities, whether topically focused and geographically dispersed (communities of interest/practice) or geographically confined (networked communities), may use various software and features, including **sharing** information resources, community histories, bibliographies, and photo archives.
- Large online communities support thousands of contributors to projects like the Linux operating system, demonstrating the effectiveness of geographically dispersed **sharing and collaboration**.
- Platforms like eBay, where millions participate to buy or sell, generate feelings of shared experiences. Sellers on eBay even collaborate to influence management policies. The Feedback Forum allows buyers to **share** comments on sellers.
- Shared public spaces with large wall displays facilitate **information sharing** and promote awareness of what others are doing.
- Web content is now expected to be fluid across platforms, and readers want to easily **share** content with friends and coworkers.
- The increase in video content, fueled by cellphones and video-sharing services like YouTube and Vimeo, enables extensive **sharing** of visual information.
- Social search explicitly involves **sharing**, such as searching restaurant reviews provided by thousands or asking friends for recommendations via social media. Aggregated use data, like "Most viewed" and "Most shared" buttons, also represents a form of explicit **sharing** signal.
- Social bookmarking and ranking sites like Diggs, Reddit, or Delicious collect recommendations from thousands ("the wisdom of the crowd") and rank items by popularity, leveraging collective **sharing**.
- Visual analytics tools, like Spotfire, support the analysis life cycle by enabling users to **share** shareable formats of charts and datasets and publish visualizations on the web or **share** them on social media platforms like Facebook, Twitter, and LinkedIn.

- Tag clouds and word clouds, which scale words based on frequency, originated on the social photo **sharing** website Flickr.
- Crowdsourcing is a powerful tool that recruits participants to generate ideas, collect data, and make useful inputs, representing **sharing** on a large scale. Companies like Google, Facebook, and IDEO use crowdsourcing for testing ideas and gathering feedback.
- Many people are willing to **share** their self-tracked data (e.g., health metrics) with their social networks, which has been found to enhance their networking and motivation.
- The Internet has proven to be a powerful way of connecting millions with a common interest, enabling the **sharing** of content that can go viral, such as retweeting photos.
- Citizen science and citizen engagement projects leverage the Internet, smartphone apps, and **social media** to galvanize and coordinate the efforts of millions in **sharing** data and participating in scientific or governmental activities.

In summary, the sources depict **social media** and **social networking** as dominant modern platforms for communication and interaction, characterized by the creation and **sharing** of user-generated content and the formation of vast online communities and networks. The ability to **share with others** through various technological means—from simple messaging and document collaboration to sharing photos, videos, analytics, and personal data—is a central aspect facilitated by these platforms, transforming social interactions, work practices, and even civic participation, while also introducing important considerations regarding privacy and ethical design.

COLLABORATIVE ENVIRONMENTS

C**ollaborative environments** are contexts where individuals work or interact together, often facilitated by technology. These environments encompass a wide spectrum, ranging from people physically present in the same location to those dispersed across time and space. **Computer-Supported Cooperative Work (CSCW)** is the field concerned with designing systems to support group working and understanding the effects of technology on work patterns. While early computer use was often isolated, it has evolved into a lively social environment supporting interaction, learning, and staying in touch.

Collaborative environments can take many forms:

- **Face-to-Face (Same Place, Same Time)**: Teams working in the same room using shared technology, such as pilots in a cockpit, air-traffic controllers, stock traders, brainstorming or design teams, and students in classrooms with interactive whiteboards or projectors. Electronic meeting rooms, control rooms, and public spaces with wall displays also fit this category.
- **Synchronous Distributed (Different Place, Same Time)**: People at remote sites working together concurrently. Examples include video conferencing, chat, instant messaging, texting, and synchronous editing of documents. Collaborative virtual environments (CVEs) also enable real-time interaction between remote participants. Telepresence, often supported by immersive 3D virtual environments, aims to give remote participants an experience close to being physically co-present.
- **Asynchronous Distributed (Different Place, Different Time)**: Collaboration where participants interact at different times. This is a common form facilitated by electronic mail, newsgroups, listservers, online communities, and collaborative document editing where users

take turns. Collaboratories, which allow scientists or professionals to work together across time and space, often find asynchronous technologies most valuable.
- **Mixed**: Many collaborations involve a mixture of asynchronous and synchronous communication. Workplaces often have a rich ecology of people, physical artifacts, and electronic systems.

A framework based on a 2x2 matrix of time (same/different) and space (same/different) is useful for classifying collaborative interfaces. However, the term "asynchronous" can be ambiguous.

ISSUES FOR COOPERATIVE WORKING

There are various **issues for cooperative working** that designers must address:

- **Social and Behavioral Challenges**: Collaboration involves subtle questions of etiquette, trust, and responsibility. There is also the potential for anxiety, deceit, desire for dominance, and abusive behavior. Social acceptability is critical for the success or failure of group technologies. Collaborative interfaces must accommodate community values and create acceptable social norms. The almost universal adoption of social media has fundamentally changed social networks and family ties, and raises questions about preserving personal trust and organizational loyalty as interactions shift from face-to-face to screen-to-screen. Social hierarchy can inhibit communication. User frustration can result from distractions, technology issues, layout, or people issues.
- **Organizational and Contextual Issues**: Technology is used within a specific context and is influenced by many factors, including other people, other electronic devices, and paper resources. Workplaces involve complex interactions and unexpected interruptions are regular. Organizational issues affect technology acceptance and must be considered. Groups and organizations have conflicting goals, which systems must acknowledge to avoid failure. Introducing new systems can change existing practices. Solutions must match existing social and organizational structures. Geographic distance matters; physical presence affords unplanned interactions and rapport building ("watercooler" talk) which can be essential to project success. Distributed groups can lead to the problem of the "invisible worker," where physical presence might increase perceived worth for promotion. Motivating employees to help colleagues when in competition for promotion can be challenging in communities of practice.
- **Design and Implementation Difficulties**: Designing for collaboration is challenging. Determinants of success for collaborative interfaces are still unclear. Causes of failures in work-oriented groupware include disparities between who does the work and who gets the benefit. Potential problems include threats to existing political power structures, insufficient critical mass of users with convenient access, violation of social taboos, and resistance to change. When devices are remote, designers must cope with slower responses, incomplete feedback, increased likelihood of breakdowns, and complex error-recovery procedures. Implementing synchronous groupware is particularly difficult due to network delays, the number of components that can fail, and single-user assumptions built into graphical toolkits. Handling multiple updates from several users while keeping data consistent and displays synchronized is a significant problem. Poor design, slow implementation, or inadequate functionality can undermine acceptance. Novelty of approaches like advanced direct manipulation or virtual environments can lead to unexpected problems. Getting the right level

of control between users and the system is critical. Multiple-desktop displays can introduce discontinuities and misalignments. Accommodating interruptions from messages/alerts is an issue.

- **Evaluation Challenges**: Evaluating the benefits of cooperative systems, especially organization-wide ones, is difficult; benefits are often in terms of job satisfaction or fluid information flow, which are hard to measure objectively. Metrics like the number of participants, messages, or return visits can indicate success, but subjective measures like satisfaction and sense of belonging are also important. Ethnographic observation can provide subjective measures. Business managers need cost/benefit analyses, although reducing travel costs with video conferencing might eventually lead to increased travel as face-to-face desire grows. Evaluating collaborative systems is difficult out of context; they must be evaluated within the organizational culture where working relationships are considered. The system and practice must evolve together. Laboratory studies of group working are difficult because interpersonal communication is heavily dependent on context, and the artificial environment may not reflect real-world issues like interruptions. Choosing suitable tasks for groupware experiments that encourage active cooperation is also challenging.
- **Communication Specifics**: Electronic mail can be too loosely structured, overwhelming, difficult to navigate, and hard for late joiners to catch up. Computer presentations in meetings can interfere with communication by reducing eye contact. In shared public spaces with wall displays, coordination can be complex and technology distractions might interfere. Computer-mediated communication can lose subtle cues from face-to-face interaction like body language, tone, and eye contact. Text-based communication has weaker constraints regarding timing and sequence compared to face-to-face. WYSIWIS (what you see is what I see) is important but can be difficult to maintain, especially with remote shared work surfaces, leading to issues like "scroll wars". Indirect communication through shared artifacts (files, databases) can be a weak form of collaboration.

TECHNOLOGIES TO SUPPORT COOPERATIVE WORKING

Numerous **technologies support cooperative working**:

- **Basic Communication Tools**: Electronic mail, chat, instant messaging (IM), texting, and telephone are fundamental for communication and collaboration. Newsgroup and listserver systems support broader discussions and information sharing.
- **Shared Workspaces and Document Collaboration**: Groupware enables remote collaborators to work concurrently on shared documents, maps, spreadsheets, or images. Collaborative document production is supported by tools allowing asynchronous or synchronous editing. Shared work surfaces like electronic whiteboards and large wall displays facilitate information sharing and awareness in both face-to-face and remote settings. File-sharing tools and shared databases can serve as loci for cooperation, although this is a weaker form of collaboration.
- **Meeting and Coordination Support**: Electronic meeting systems facilitate face-to-face meetings with features like shared displays, simultaneous contributions, and voting. Electronic schedulers, shared calendars, project management tools, and workflow tools

support coordination by managing tasks and dependencies. Argumentation tools help record the rationale behind decisions, useful for design teams.
- **Remote Presence and Virtual Environments**: Video conferencing supports synchronous remote communication. MediaSpaces provide environments for remote participants using video, audio, and computing. Collaborative virtual environments and telepresence systems allow users to interact in shared 3D spaces. Robotics and MRP devices can enable remote participation and interaction.
- **Platforms and Communities**: Online communities, built on platforms like listservers or websites, fill with useful information and support. Social networking accounts are used for getting news, connecting, and coordinating. Social coding platforms, file-sharing tools, and project management tools support creative production by dispersed teams. Online directories can facilitate reaching large groups. Social media platforms in general enable the sharing of user-generated content.
- **Novel and Emerging Technologies**: Interactive wall displays, multitouch screens, and tabletops (shareable interfaces) are being developed to enhance co-located collaboration. Mobile devices have expanded capabilities for communication and sharing via voice, text, photos, and videos. Multimodal systems that recognize speech, gesture, and eye movements are areas of research. Crowdsourcing recruits participants for large-scale idea generation, data collection, and input. Bar codes are a computerized form of deixis facilitating large-scale, diffuse cooperation. Tools for social media data collection and analysis exist.

These technologies aim to support the main social mechanisms people use in collaboration: conversation, coordination, and awareness. While improving communication is a goal, supporting effective cooperation requires more than just good communication tools; participants must be able to cooperate about their work. The design of communication tools and platforms, along with the qualities and intentions of the people involved, play a significant role in achieving successful outcomes.

AI AND INTERFACE AGENTS

The concepts of Artificial Intelligence (AI) and Interface Agents are closely related and have been significant topics in Human-Computer Interaction (HCI).

Artificial Intelligence and Agents

Software agents, in the human world, are people who work on someone's behalf. Similarly, **software agents act on behalf of users within the electronic world**. Examples include email agents that filter mail or web crawlers that search for documents. Agents can perform repetitive tasks, watch and respond to events, and even learn from user actions.

Many designers are eager to create an **autonomous agent** that knows users' preferences, makes inferences, responds to novel situations, and performs competently with little guidance. There is a belief among some designers that human-human interaction is a good model for human-computer interaction, leading them to seek computer-based partners, assistants, or agents.

The concept of agents includes aspects of both language and action paradigms in HCI. While old command-based systems acted as intermediaries you asked to do something, agents act on the user's behalf, often within a world the user could also act upon. This is likened to a shop assistant in a supermarket who helps you as you browse, rather than a traditional shopkeeper who brings items to you.

The Debate and Challenges of Agents/AI in Interfaces

There has been a **controversy over whether to create tool-like interfaces or to pursue autonomous, adaptive, or anthropomorphic agents**. Many designers believe tool-like interfaces are often more attractive than agents that carry out users' intentions and anticipate needs.

Advocates of anthropomorphic interfaces assume that human-human communication is an appropriate model for computer operation. However, some designers pursue this human-imitation approach even after it becomes counterproductive. Mature technology has overcome the trap of animism (attributing spiritual essence to non-human things), which has hindered technologists for centuries. Historical examples of failed anthropomorphic interfaces like the bank tellers Tillie the Teller and Harvey Wallbanker, Microsoft's BOB program, the much-criticized Clippy character, and the Postal Buddy, do not seem to deter some designers. These examples suggest that while such agents were intended to be friendly or helpful, they were ultimately unsuccessful or withdrawn.

The scenarios of **artificial intelligence (smart machines, intelligent agents, and expert systems) are described as "mind-limiting distractions" that inhibit designers from creating more powerful tools**. The sources suggest that the next generation of commercially successful interfaces for collaboration, visualization, simulation, and teleoperated devices are likely to come from user-centered scenarios rather than machine-centered artificial intelligence scenarios.

Despite advancements in AI, the vision of computers chatting leisurely about open-ended topics remains more fantasy than reality. Errors remain a significant challenge, and not all situations benefit enough from speech input to balance the cost of errors and the frustration of error correction. Even in science fiction, newer scenarios have reduced the use of spoken interaction in favor of larger visual displays and gestures.

Introducing autonomous agents also raises questions about accountability and liability for failures. There are increasing expectations that AI researchers find ways of explaining the rationale behind decisions made by AI systems, a need often referred to as transparency and accountability.

In the context of collaboration, supporting effective cooperation requires more than just good communication tools; participants must be able to cooperate about their work [prev. turn].

The Role of AI in Modern and Future Interfaces

Despite the debate, AI is becoming increasingly pervasive. It is now replacing the user interface for applications where users previously had to make choices. The goal is to reduce the stress of decision-making and potentially improve upon human choices. Examples include smartphones learning music preferences or home heating systems deciding when to turn on/off based on learned behavior. While there are benefits, this can lead to a loss of control and difficulty understanding why a system made a particular choice.

Advancements in AI and automation are seen as having the potential to empower humans and enable previously unimaginable things. The key to unlocking this potential is creating efficient ways for interacting with AI. Meaningful automation and intelligent systems have boundaries and intersections with human action, making the design of interaction and interfaces even more crucial. Creating a positive user experience with AI is a challenge requiring new visions and metaphors.

One suggested concept is **intervention user interfaces**, where intelligent systems work without human interaction most of the time, but easily allow for human interventions to maintain control, tailor the system, or customize the experience. Designing these interfaces to empower users is a huge challenge with many basic research questions. Getting the interaction with AI right, enabling humans to harness its power for their goals, is as important as developing the underlying algorithms.

An emerging class of interfaces relies on subtle, continuous changes triggered by implicit user information and AI algorithms that learn user behavior and preferences. By using various sensors (brain, body, behavioral, environmental), real-time cognitive and emotional states can be captured. Adding AI allows for new interface types that go beyond "natural" or "smart," potentially enabling users to develop "superpowers" to work synergistically with technology on complex problems and "unimaginable feats".

Types of Interface Agents

There are different kinds of agents based on their degree of anthropomorphism and the human or animal qualities they emulate:

1. **Synthetic characters:** Often 3D characters in games or entertainment, designed to be lifelike with realistic movements, distinct personalities, and detailed appearance and facial expressions. Can appear as a first-person avatar or a third-person agent.
2. **Animated agents:** Similar to synthetic characters but typically designed to play a collaborating role at the interface, often appearing at the side of the screen as tutors, wizards, or helpers for specific tasks. Most are cartoon-like rather than resembling humans. Herman the Bug is an example developed to teach children biology.
3. **Emotional agents:** Designed with a predefined personality and set of emotions manipulated by users, aiming to show the effect of mood changes on behavior through interface controls like sliders or icons.
4. **Embodied conversational interface agents:** Much research focuses on emulating human conversation, including recognizing/responding to verbal and non-verbal input, generating output, coping with breakdowns, turn-taking, and signaling conversation state.

Avatars, which represent users rather than computers, have remained popular in gaming and 3D social environments. Users seem to enjoy the theatrical experience of creating a new identity. This is distinct from agents representing the computer itself.

AI and Emotion/Behavior

Emotional AI and affective computing are research areas concerned with using AI and sensor technology to recognize and express emotions. This involves designing ways for people to communicate their emotional states using sensors and analyzing expressions and conversations to infer emotions. AI technologies can analyze facial expressions and voice to infer emotions and potentially predict user behavior based on their emotional state. While these technologies exist, their use is primarily in research and analysis rather than conversational interfaces, though virtual assistants like Alexa can be configured to respond to politeness.

In summary, AI is increasingly integrated into system design with the potential to create more intelligent and autonomous interfaces, often conceptualized as agents acting on behalf of the user. However, the historical failures of anthropomorphic agents and ongoing challenges related to user control, transparency, and the fundamental debate between agent-like versus tool-like interfaces continue to shape the field of HCI and the design of collaborative environments. Technologies supporting cooperative working are evolving to incorporate AI, moving towards systems that learn and anticipate user needs, though human interaction and understanding remain critical.

UBIQUITOUS COMPUTING

Ubiquitous computing, also referred to as pervasive computing, was proposed by Mark Weiser as an interaction paradigm where **computers disappear into the environment so that users are no longer consciously aware of them**. Weiser envisioned computing devices becoming so commonplace that they would not be distinguished from the 'normal' physical surroundings. The goal is for technology to be seamlessly integrated into the physical world, enhancing existing capabilities rather than creating artificial ones. This vision challenges the traditional desktop interaction paradigm, moving computational power into the user's surrounding environment.

Weiser's dream was for computers to "permeate our physical environment so much that we do not notice the computers anymore". This is different from simply making computers portable; it involves designing technology to be invisibly integrated, making everything faster and easier with less cognitive effort. This ideal aligns with making the computer "vanish" as users become completely absorbed in their tasks.

Weiser described the form factor of ubiquitous computing technology in three scales: the inch (like PDAs, pagers, cellular phones), the foot (like standard laptops and desktop displays), and the yard (large, wall-sized displays shared by groups). The trend is towards a pervasive computing experience where devices are distributed throughout the physical world and more tightly integrated with it.

Key aspects of ubiquitous computing applications include:

- **Shifting Interaction:** Moving away from the desktop keyboard/mouse/display paradigm towards more physical interaction like speaking, gesturing, and using writing implements.
- **Diverse Displays:** Utilizing various sizes and scales of visual displays (inch, foot, yard) distributed throughout environments, not just self-contained desktop screens.
- **Peripheral Awareness:** Designing output to be less demanding of attention, providing information at the periphery of senses through ambient displays. An example is the Dangling String ambient display which used analog sensing of network traffic.
- **Context Awareness:** Applications that are informed about the context of their use to work seamlessly and with minimal distraction. Sensor-rich environments can detect a user's state or needs, allowing interfaces to respond implicitly to expressions and gestures. Active badges with RFID tags can trigger actions like preloading files when a user enters a room.
- **Automated Capture:** Systems that easily capture and store memories of live experiences for later use, explored initially for meeting support systems.
- **Continuous Interaction:** Moving computing from a localized tool to a constant presence, supporting informal, unstructured everyday activities.

Understanding interaction in ubiquitous computing requires shifting focus from a single machine to broader social and environmental arrangements, moving away from office-centric, task-oriented models towards understanding interaction in everyday life.

BLENDED SPACES

The concept of "blended spaces" is to i**ntegrate digital information and interaction with the physical environment**. Ubiquitous computing itself aims to activate the world by embedding wireless computing devices of various scales everywhere. This inherently creates blended spaces where the physical and digital worlds coexist and interact.

Several specific technologies that facilitate blended space:

- **Tangible User Interfaces (TUIs) / Tangible Bits:** This paradigm focuses on **integrating computational augmentations into the physical environment** by coupling digital information to everyday physical objects and environments. Examples include physical objects like blocks or models that, when manipulated, cause digital events to occur on a surface. Tangible interfaces treat physical objects as artifacts that users can directly act upon, lift, rearrange, and manipulate. This approach allows physical objects and digital representations to be combined and explored in creative ways, potentially leading to greater insight and problem-solving than with traditional interfaces. It also allows for more than one person to interact with the interface simultaneously. Tangible computing involves a coordinated interplay of different physical devices and objects, with no single locus of control or enforced sequence of actions.
- **Augmented Reality (AR):** AR keeps users in their normal surroundings but adds a **transparent overlay of digital information**. This virtual content is superimposed onto the real world. Examples include adding names of buildings or visualizing hidden objects.
- **Virtual Reality (VR):** While AR blends the physical and digital, VR typically blocks out normal surroundings with a head-mounted display to present a completely artificial, immersive world. However, VR also creates a "blended space" in the sense of creating a digital environment that users physically inhabit and interact with using gestures or specialized devices like datagloves. Research explores the design of interaction within these immersive environments.
- **Ambient Interfaces/Displays:** These are designed to provide information at the periphery of user attention, often subtly changing environmental elements like light, sound, or airflow. This embeds computing output directly into the physical space, blending digital information with the user's surroundings.
- **Large Wall Displays and Interactive Surfaces:** These "yard-scale" ubiquitous computing devices provide large shared visual spaces where users can interact and collaborate directly with digital content within a physical room. Examples like the SMART Board allow interaction with fingers or pens, locally or remotely. These displays turn physical walls or tabletops into interactive surfaces, directly blending the digital workspace with the physical meeting space.
- **Sensor-Based and Context-Aware Interaction:** By embedding sensors into the environment and objects, systems can react to implicit user information and context. This enables computing to respond to physical location, presence, gestures, and even inferred emotional states. This deep embedding of sensing technology into the environment is fundamental to

ubiquitous computing and directly supports creating spaces where physical actions and context trigger digital responses.

These technologies collectively represent the movement towards creating blended spaces where computation is not confined to traditional devices but is integrated into the environment, allowing interaction through natural physical actions and context, realizing aspects of the ubiquitous computing vision.

MOBILE COMPUTING- DESIGNING FOR MOBILES

Mobile computing represents a paradigm where computing is no longer confined to a desktop but is deeply woven into the fabric of our everyday existence. The traditional computer platform, which involved a desktop or laptop with a screen, mouse, and keyboard, has been revolutionized by mobile devices like smartphones, tablets, and portable MP3 players. These are not just portable devices; they are powerful computers that have become the universal computing platform for the world. The sources indicate the prevalence of mobile devices, noting there are easily more than 5 billion mobile devices in existence, with over 25% being "smart" and internet-connected, compared to about 800 million personal computers. This shift is global, quickly becoming an integral aspect of life even in rural and underdeveloped regions.

The shift towards mobile computing moves "beyond the desktop" paradigm. Mobile devices come in various form factors, including smaller devices like Palm Tungstens, iPods, Nokia phones, Blackberries, and Microsoft Pocket PCs. They challenge the traditional desktop interaction paradigm of keyboard, mouse, and monitor. This pervasiveness means many users today do not realize their ever-present devices are powerful computers.

Mobile devices are often used for brief but routine tasks. They are being developed in different classes based on intended usage, such as general-purpose work (like Blackberries or Pocket PCs), general-purpose entertainment (focusing on multimedia like iPods), general-purpose communication and control (extensions of phones), and targeted devices performing only a few tasks (like UPS drivers' devices).

The rise of mobile computing aligns with the broader vision of ubiquitous or pervasive computing, where computing devices become so commonplace and integrated into the physical world that users do not distinguish them from their surroundings. While ubiquitous computing envisions devices disappearing into the environment, mobile devices are tangible and portable, but their ubiquity contributes to the overall pervasive computing experience.

Designing for Mobiles

Designing for mobile devices presents unique challenges and requires specific considerations due to their characteristics. The field of interaction design has moved beyond just graphical interfaces and desktop widgets to focus on the overall interaction across various devices, including handhelds and phones.

Key design considerations for mobile interfaces include:

- **Screen Size and Displays:** Mobile devices typically have small screens and limited display space. Designers must carefully consider how to adapt content and interfaces to these small screens. Strategies include using vertical and horizontal scrolling for rapid scanning of content like images, menus, and lists, and employing techniques like adaptive rapid serial visual presentation to improve readability. Responsive web design is also used to automatically adapt layouts for smaller displays. The challenges of display design for small, wall, and mall-sized displays have renewed interest in the topic.
- **Input Methods:** Text entry on mobile devices has changed significantly from the traditional keyboard. Many older or low-cost devices use numeric keypads, requiring multiple taps for text entry. Novel strategies have emerged to meet the needs of mobile users, moving beyond the QWERTY keyboard for text input. Pointing devices like touchscreens free users from keyboards for many tasks. Touchscreens have become pervasive and the main interface for many, requiring different interaction techniques compared to traditional GUIs. Interaction techniques on touchscreens include tapping, pressing and holding, pinching, swiping, sliding, and stretching. Virtual keyboards are common, although typing speed and efficiency may differ from physical keyboards. Predictive text can help increase typing speed. Other input methods include stylus-based methods, one-handed interaction primarily using thumbs, and considering alternatives for users with disabilities.
- **Navigation:** Navigation is critical on mobile devices to allow users to find information or express choices, especially given the constrained display space. Mobile browsers have been developed to streamline viewing and navigation of online content. While swipe gestures can quickly move through digital content, it is also easy to swipe too far.
- **Context and Usage Patterns:** Mobile devices are often used for brief but routine tasks, so optimizing designs for repetitive tasks and hiding less important functions is critical. Users may only have one hand available, influencing target placement and task configuration. Designing for internationalization is also important due to the worldwide mobile market, requiring consideration of languages, character sets, and localization.
- **Conceptual Models and Interaction Styles:** Designing for mobile involves considering various conceptual models based on activities like instructing, conversing, manipulating, navigating, exploring, and browsing. Touch interfaces require alternative conceptual models for actions traditionally mapped to GUI interactions like selecting menu options or managing files. The use of objects like cards, carousels, and stacks can help users swipe and move through digital content quickly.
- **Prototyping and Evaluation:** Paper prototyping is used by mobile companies as a core part of their design process, offering a rapid way to work through the details of complex interactions on feature-rich devices. Contextual design techniques, including ethnographic research, are used to understand user requirements for mobile communicators.

Examples and Case Studies:

- Nokia's approach to designing mobile communicators involved a user-centered approach, including ethnographic research, to develop detailed requirements. Their devices featured physical controls like a power key, Navi Roller for navigation and selection, and softkeys with context-sensitive actions. Nokia also addressed optimizing websites for mobile communicators.
- The Apple Newton was highlighted as an early popular pen-based computer targeting the organizer market where miniature keyboards were difficult.

- Responsive web design, where layout adapts to different screen sizes, is mentioned as a technique for accommodating mobile displays.

Overall, designing for mobile computing requires a shift in perspective from the desktop, focusing on the unique constraints and opportunities presented by smaller form factors, diverse input methods, and the ubiquitous nature of these devices in everyday life.

WEARABLE COMPUTING- SMART MATERIALS, MATERIAL DESIGN

Wearable computing is an interaction paradigm where computational capabilities are carried by the user on their body. It is described as a theme for future innovations, suggesting devices that are personal and portable, carried by users at all times. This field has emerged from ideas behind ubiquitous computing, exploring how people can interact with digital information while on the move in the physical world. Wearables are a broad category that includes devices like smartwatches, fitness trackers, fashion tech, and smart glasses. Early experimental work by Steve Mann in 1997 involved head and eye cameras, and more recent examples include Google Glass.

New technologies such as flexible displays, e-textiles, and physical computing tools like Arduino offer opportunities to design wearables that people might genuinely want to wear. Experimentation has involved integrating technology into various items like jewelry, caps, glasses, shoes, and jackets. Early wearables often focused on convenience, such as controlling a music player integrated into a ski jacket without needing to access a handheld device. More recent developments combine textiles, electronics, and haptic technologies to enable new forms of communication, such as the CuteCircuit KineticDress which uses electroluminescent embroidery to display the wearer's mood based on their movement. Designers see embedding computers in clothing as a tool that opens up creative possibilities for dynamic and interactive garments that can perform functions like changing color, sparkling, or notifying the wearer of health information. Tools like the LilyPad have been developed to help people build new wearable technology. Wearables have become a significant interface type, following the GUI, mobile, and touch interfaces.

Designing for wearable interfaces presents specific challenges:

- **Comfort:** Wearable technology needs to be light, small, not intrusive, fashionable, and ideally have hidden electronics within the clothing.
- **Hygiene:** Considerations include whether the clothing can be washed or cleaned and the ease of removing and replacing electronic components.
- **Power:** Battery placement and lifetime are key issues.
- **Control:** Determining preferable interaction methods like touch, speech, or conventional buttons and dials is a usability concern.
- **Integration:** Combining technologies like LEDs, sensors, actuators, tangibles, and augmented reality (AR) is part of creating wearables.

Smart Materials and Material Design Concepts

While the specific term "Smart Materials" is not explicitly defined as a category, the sources discuss concepts and examples closely related to embedding computational or interactive properties into materials and physical objects, aligning with the idea of material design in HCI.

This is strongly reflected in the concept of **Tangible User Interfaces (TUIs)**, also referred to as "Tangible bits". TUIs represent a paradigm shift that augments the physical world by coupling digital information with everyday physical objects and environments. The focus is on integrating computational augmentations into the physical environment, allowing people to interact with digital information through physical objects and surfaces. Examples include physical books embedded with digital information, greeting cards that play animations, or physical bricks that affect virtual objects when manipulated. The goal is to create seamless interfaces between people, bits, and atoms.

Another related concept is **Physical Computing**, defined as creating physical artifacts and giving them behaviors by combining building with physical materials, computer programming, and circuit building. This involves using components like printed circuit boards (PCBs), sensors to detect states, and output devices (displays, motors, buzzers) to create interactive objects. An example is a cat detector built using an accelerometer, webcam, and programming. The "Sew Electric" projects further demonstrate this, combining fabric, electronics, and programming.

In the context of wearables, the use of **e-textiles** is mentioned as providing opportunities for design. Examples like clothing that can change color in response to pollution, sparkle when someone calls, or notify the wearer of increased blood pressure illustrate how materials can be designed or integrated with technology to become responsive and interactive. The use of electroluminescent embroidery in the KineticDress is another instance of integrating electronic functionality into fabric.

Furthermore, broader concepts of material design in HCI include using novel fabrication methods like **3D printing** to create physical items – such as jewelry, chairs, or building components – that can potentially incorporate or interact with computing. This reflects an increasing interest in how physical form and material properties intersect with interaction design and computation.