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

COMPUTER SUPPORTED COOPERATIVE WORK

Overview

- Definitions and terminology
- Brief history and research inspiration
- CSCW technology and infrastructure - Applications and related issues
  - Communication tools
  - Coordination support
  - Information Repositories
  - Social Computing
  - Integrated Systems
- McGraths' Framework
  - Organizational Behaviour and Support
- Challenges and Opportunities
  - Grudin's eight design challenges (1994) and the progress since then
  - Future Directions

Definitions

- CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques (Wilson, 1991)
- Computer Supported Cooperative Work (CSCW) involves a community of behavioral researchers and system builders at the intersection of collaborative behaviors and technology
- The collaboration can involve a few individuals or a team, it can be within or between organizations, or it can involve an online community that spans the globe
- CSCW addresses how different technologies facilitate, impair, or simply change collaborative activities (Grudin, 2013)

Terminology disambiguation (1/2)

- In the several decades since networked computing made possible the kinds of software functions presented, terms have changed
- In the 1990s it was popular to refer to such software as groupware
  - This term has largely been supplanted by terms more neutral as to the level of social aggregation involved
- A more appropriate generic term is Collaboration technology (Olson and Olson, 2012) since the field has moved beyond the focus on work only but the term CSCW persists
  - The leading conference is named CSCW
  - Schmidt (2010) argues that the focus on work is significant enough to merit an undiluted field of study

Terminology disambiguation (2/2)

- The terms *computer, support, cooperative,* and *work* have all been transcended
- CSCW encompasses:
  - collaboration that uses technologies we do not call computers
  - collaboration in which technology plays a central rather than a support role
  - uses that involve conflict, competition, or coercion rather than cooperation
  - studies of entertainment and play
- The field of CSCW that had come together around groups in organizations in the 1990s has now split again, with North America highly focused on social media and online community and European CSCW focused on organizational issues and domain-specific research and development
- CSCW has become more prominent in Asia and South America as well, with elements of each focus. It is plausible that these efforts will converge again as social media move into widespread use in a broad range of organizations

The Emergence of CSCW – brief history

- In 1984 Irene Greif and Paul Cashman coined the acronym CSCW for an invited workshop focused on understanding and supporting collaboration
- Technology capable of supporting a group of people was so expensive that workplace deployment was the sole focus
- A major topic was email, which in 1984 was poorly designed, not interoperable across different platforms, and used primarily by researchers
- The first open CSCW conference was held in 1986
- CSCW soon became the principle research forum for the collaboration that was newly enabled by emerging client-server PC and workstation networks

Original research inspiration

- In 1988, Greif published *Computer-Supported Cooperative Work: A book of readings* (Greif 1988)
- Four of the first five papers describe the inspirational research led by Douglas Engelbart between 1963 and 1984
  - Engelbart is best known for inventing the mouse, but he had a far broader vision for augmenting human intellect and building high-performance teams through technology
  - The NLS system he and his colleagues developed and used included many features that took decades to become widely used, including desktop and video conferencing

NLS

- Douglas Engelbart and staff using NLS to support 1967 meeting with sponsors - probably the first computer-supported conference
- The facility was rigged for a meeting with representatives of the ARC's research sponsors NASA, Air Force, and ARPA
- A U-shaped table accommodated setup CRT displays positioned at the right height and angle
- Each participant had a mouse for pointing
- Engelbart could display his hypermedia agenda and briefing materials, as well as the documents in his laboratory's knowledge base

CSCW Technology

	Real time	Asynchronous
Communication	• Telephone • Video conferencing • Instant messaging • Texting	• Email • Voice mail • Blogs • Social networking sites
Information sharing	• Whiteboards • Application sharing • Meeting facilitation • Virtual worlds	• Document repositories • Wikis • Web sites • Team workspaces
Coordination	• Floor control • Session management • Location tracking	• Workflow management • CASE tools • Project management • Calendar scheduling

A two-dimensional collaboration framework with examples of technology features or products found within each cell (Grudin 2012)

Technical Infrastructure – advances and challenges (1/2)

- Heterogeneity in network conditions remains a major technical challenge
  - Doing web-conferencing when some participants are on slow lines and others are on fast advanced networks requires special coordination
- The World Wide Web and its associated tools and standards have had a major impact on the possibilities for collaboration
  - Early collaboration technologies consisted of stand-alone applications that had to be downloaded and run on each client machine
- Increasingly, collaborative tools are written for the web, requiring only a web browser and perhaps some plug-ins
  - Many conferencing tools are now accessed through a web browser
  - Much easier for the user and also helps with matters such as version control
  - Also enables better interoperability across hardware and operating systems

Technical Infrastructure – advances and challenges (2/2)

- Explosion of collaborative functions on mobile devices
  - Laptops, PDAs, wearables, tablets and smartphones provide access to information and people from almost anywhere
  - These devices vary in computational power, display size and characteristics, network bandwidth and connection reliability providing technical challenges to make them all interoperate smoothly
- Security on the internet continues to be a major challenge for collaboration technologies
  - The design of internet protocols is to blame in some sense, since they were developed in a culture of openness and sharing
  - E-commerce and sensitive application domains like medicine have been a driver in advances in security
  - Additional flexibility is being provided by development of infrastructure that lies between the network and the applications that run on client workstations, “middleware”
    - Middleware provides such services as identification, authentication, authorization, directories and security in uniform ways

Communication Tools

E-mail

- Can be done from smartphones, tablets, TVs and kiosks in public sites
- Can exchange any kind of document
- Because of its widespread use it has often been called the first successful collaboration technology
- E-mail overload has become a major problem
- Can become a vector for viruses, worms and other malware
- People use e-mail in ways that it was not designed for:
  - Managing time, reminders, keeping track of steps in the workflow
  - Since it was not designed for those tasks, it does not do it very well
    - Struggle reading signals about whether users have replied or not (and to whom it was cc'd), poor folder management for reminding things, etc.

E-mail: effects on behaviour

- Large effects on communication in organizations. It changes:
  - the social network of who talks to whom
  - The power of people who formerly had little voice in decisions
  - The tone of what is said and how it is interpreted
    - E.g., with e-mail, people who were shy found a voice, overcoming their reluctance to speak to other people by composing text, not speech to another face
    - On the other hand, invisibility has a more general effect – without the social cues in the recipient's face being visible to the sender, people will "flame", send harsh or extremely emotive (usually negative) messages

Conferencing tools: Voice, video, text

- Computer-mediated communication (CMC) has become widespread and there are many options available today for online conferencing among geographically dispersed members of a group
- Three principal modes of interaction:
  - Video & audio
    - Full-scale video conferencing room; many options for specific design
    - Individual desktop video; many options for quality, interface
    - Conferencing options on mobile devices
  - Audio
    - Phone conference
    - Voice over IP (Skype being extremely popular)
  - Text
    - Instant messaging (IM), chat, SMS on mobile

CMC vs FTF (face-to-face)

- CMC is more difficult to do than FTF
  - Requires more preparation and care
  - Things that come for free in FTF are either difficult to support or outright missing in CMC
    - Backchannel communication, which is important for modulating conversation, is either weak or non-existent in CMC
    - It has become common to keep an IM chat going during audio or video conferences
    - Paralinguistic cures that can soften communication are often missing
    - Participants in CMC tend to have an informational focus, which means less socializing, less small talk – over time this can lead to poorer social integration and organizational effectiveness
  - CMC often introduces delay, which is very disruptive for communication
    - Participants will communicate less information, be more frustrated and actually terminate sessions sooner
    - If there is delay, full duplex communication will not work since participants will step over each other's communication
      - Participants must use a social protocol (like radio communications with spacecraft) or employ a mike-passing procedure with interface indications of who wants to talk next

Audio and Video social ergonomics

- The social ergonomics of audio and video are keys to their success
  - Many of the failures of audio conferencing, especially over the Internet, result from poor-quality microphones, poor microphone placement, poor speakers, and interfering noises like air conditioning. Getting these details right is essential
  - Similarly, for video, camera placement can matter a lot
    - For instance, Huang, Olson, and Olson (2002) found that a camera angle that makes a person seem tall (as opposed to actually being tall) affects how influential a person is in a negotiation task. Apparent height matters a lot

Key features for successful remote meetings

- The ability to share the objects they are talking about
  - such as the agenda, the to-do list, the latest draft of a proposal, a view of an object to be repaired, and so on
- Many researchers have provided experimental evidence of the value of a shared workspace for synchronous audio-supported collaboration
- More traditional video conferencing technologies often offer an "object camera," onto which the participants can put a paper agenda, Powerpoint slides, or a manufactured part
- More generally, any form of video can also be used to share work objects
- For digital objects, there are now a number of products that will allow meeting participants to share the screen or, in some cases, the remote operation of an application
  - Some companies are using electronic whiteboards, both in a collocated meeting and in remote meetings to mimic the choreography of people using a physical whiteboard
  - In some "collaboratories," scientists can even operate remote physical instruments from a distance and jointly discuss the results

Instant Messaging (IM)

- IM has emerged as a significant communication medium in the workplace, and is used even when other, richer communication channels are available
  - Muller et al (2003) found in a survey study of three organizations that instant messaging was used for "substantive business purposes" and led to significantly less use of such communication channels as e-mail, voice-mail, telephone, teleconference, pager, and face-to-face
  - In a study of IM logs in an organization, Isaacs et al (2002) found that a large proportion of IM conversations involved "complex work discussions"
  - They found that IM users seldom switched to another communication channel once they were engaged in IM
  - Nardi et al (2000) observed in a field study that workers used IM for a variety of purposes, not just for information exchange
    - Quick questions, scheduling, organizing social interactions, and keeping in touch with others

Disaster Response

- Within the past decade the CMC tools mentioned have emerged as major resources for dealing with disasters
- There are now a number of studies of these phenomena
  - For example, Vieweg et al (2010), studied the use of Twitter in two natural emergencies, the 2009 grass fires in Oklahoma and the 2009 flooding of the Red River. They found that the use of Twitter made major contributions to situational awareness in both cases
  - Palen et al (2009) studied the role of CMC in the 2007 mass shooting at Virginia Tech
  - Mark et al (2009) looked at the role of CMC in maintaining resilience in a war zone, particularly Iraq
  - Schaffer et al (2007) looked at emergency management planning in a community, focusing on what kind of software architecture would support the kinds of needs faced there
- All these examples (there are many more) are showing that the wide variety of collaboration technologies now available can have a substantial impact on emergencies

Coordination support

Support of face-to-face meetings

Meeting support – Group Decision Support Systems

- Group Decision Support Systems (GDSSs) arose from a number of business schools, focusing on large meetings of stakeholders intent on going through a set series of decisions, such as prioritizing projects for future funding (Nunamaker et al, 1991)
  - With the help of a facilitator and some technical support, the group was led through a series of stages: brainstorming without evaluating, evaluating alternatives from a variety of positions, prioritizing alternatives, and so on.
  - These meetings were held in specialized rooms in which individual computers were embedded in the tables, networked to central services, and summary displays shown "center stage"
  - A typical scenario involved individuals silently entering ideas into a central repository, and after a certain amount of time, they were shown ideas one at a time from others and asked to respond with a new idea triggered by that one
  - Later, these same ideas were presented to the individuals who were then asked to rank or rate them according to some fixed criterion, like cost
  - Aggregates of individuals' opinions were computed, discussed further and presented for vote. The system applied computational power (for voting and rating mechanisms), and networking control (for parallel input) to support typically weak aspects of meetings
  - These systems were intended to gather more ideas from participants, since one didn't have to wait for another to stop speaking in order to get a turn. And, anonymous voting and rating was intended to insure equal participation, not dominated by those in power
- Evaluations of these GDSSs have been reviewed producing some generalizations about their value
  - The systems indeed fulfill their intentions of producing more ideas in brainstorming and having more evaluative comments because of anonymity
  - Decisions are rated as higher in quality, but the meetings take longer and the participants are less satisfied than those in traditional meetings

Meeting support – Shared documents (1/2)

- A second class of technologies to support real-time meetings is less structured, more similar to individual workstation support
- In these systems, groups are allowed access to a single document or drawing, and can enter and edit into them simultaneously at will
- Different systems enforce different “locking” mechanisms (e.g., paragraph or selection locking) so that one person does not enter while another deletes the same thing (Ellis et al, 1991)
- Some also allow parallel individual work, where participants view and edit different parts of the same document, but can also view and discuss the same part as well
- This kind of unstructured shared editor has been shown to be very effective for certain kinds of free-flowing meetings, like design or requirements meetings (Olson et al, 1993)

Meeting support – Shared documents (2/2)

- The rated quality of the meeting products (e.g., a requirements document or plan) was higher when using these technologies than with traditional whiteboard or paper-and-pencil support, but like working in GDSSs, people were slightly less satisfied
- The lower satisfaction here and with GDSSs may reflect the newness of the technologies
  - people may not have yet learned how to persuade, negotiate, or influence each other in comfortable ways, to harness the powers inherent in the new technologies
- These new technologies did indeed change the way in which people worked
  - They talked less and wrote more, building on each other's ideas instead of generating far-reaching other ideas
  - The tool seemed to focus the groups on the core ideas, and keep them from going off on tangents
  - Many participants reported really liking *doing* work *in* the meetings rather than spending time only *talking about* the work

Meeting support – electronic whiteboards

- A third class of meeting room support appears in electronic whiteboards
  - For example, the LiveBoard (Elrod et al., 1992), SoftBoard and SmartBoard are approximately 46 rear projection surfaces that allow pen input, much the way a whiteboard or flipchart does
- People at Xerox PARC and Boeing have evaluated the use of these boards in meetings in extended case studies
- In both cases, the board was highly valued because of its computational power and the fact that all could see the changes as they were made
- At both sites, successful use required a facilitator who was familiar with the applications running to support the meeting
- At Xerox, suggestions made in the meeting about additional functionality were built into the system so that it eventually was finely tuned support for their particular needs (Moran et al., 1996)
  - For example, they did a lot of list making of freehand text items. Eventually, the board software recognized the nature of a list and an outline, with simple gestures changing things sensibly.
    - For example, if a freehand text item was moved higher in a list, the other items adjusted their positions to make room for it
  - The end product was not only a set of useful meeting tools, but also a toolkit to allow people to build new meeting widgets to support their particular tasks

Large displays for collaboration

- As technological developments have enabled the creation of large, affordable displays, research has picked up on the unity of large displays for small team collaboration
- An obvious application of large displays is for complex, high-resolution data, such as maps, medical images and a variety of complex scientific visualizations
- There are many interesting issues in dealing with such large displays, such as
  - how to navigate them when they are extraordinarily rich in detailed information,
  - how to distribute control among users (e.g., single selection device vs. one per person)
  - how to deal with sensitive or private information, as in the context of shift changes in a hospital
  - Robertson et al (2005) have a good discussion of the many usability issues that arise with large displays
- Tabletop displays constitute another way of presenting lots of information for collaborators. This too is a rapidly growing area of research
  - see also Augmented Reality – Collaborative AR

Meeting support - conclusion

- Meetings are important, though often despised, organizational activities
- Laboratory research has shown quite clearly that well-designed tools can improve both work outcomes and participant satisfaction
- However, meetings in organizations seldom use such tools. Inexpensive mobile computing and projection equipment combined with many commercial products mean that such tools are within reach of most organizations
- But not having these elements readily available in an integrated way probably inhibits their widespread adoption
- While traditional meetings are often viewed as wasteful and frustrating, there can be huge benefits to working together in collocated environments
- Kiesler and Cummings (2002) reviewed a number of the characteristics of physical collocation that can benefit performance
- In a detailed study of one such situation, Teasley, Covi, Krishnan, and Olson (2002) found that "radical collocation," in which software development teams worked together in a dedicated project room for many weeks, dramatically improved their productivity
- Reasons for this included the constant awareness of each other's work status, the associated ability to instantly work on an impasse as a group, and the availability of rich shared artifacts generated by the project

Group calendars (1/2)

- A number of organizations have now adopted online calendars, mainly in order to view people's schedules to arrange meetings
- The calendars also allow a form of awareness, allowing people to see if a person who is not present is expected back soon
- Individuals benefit only insofar as they offload scheduling meetings to others, like to an administrative assistant, who can write as well as read the calendar. And, in some systems the individual can schedule private time, blocking the time but not revealing to others his or her whereabouts

Group calendars (2/2)

- On-line calendaring is a classic case of what Grudin (1988) warned against, a misalignment of costs and benefits
  - the individual puts in the effort to record his/her appointments so that another, in this case a manager or coworker, can benefit from ease of scheduling
- However, since the early introduction of electronic calendaring systems, many organizations have found successful adoption
- Apparently such success requires a culture of sharing and accessibility, something that exists in some organizations and not others
- Today group calendars are common piece of infrastructure in many settings

Awareness (1/2)

- In normal work, there are numerous occasions in which people find out casually whether others are in and, in some cases, what they are doing.
  - A simple walk down the hall to a printer offers numerous glances into people's offices, noting where their coats are, whether others are talking, whether there is intense work at a computer, and so on
- This kind of awareness is unavailable to workers who are remote
- Some researchers have offered various technology solutions
  - some have allowed one to visually walk down the hall at the remote location, taking a five second glance into each passing office (Bellotti & Dourish, 1997; Fish, Kraut, Root, & Rice, 1993)
  - Another similar system, called "Portholes," provides periodic snapshots instead of full-motion video (Dourish & Bly, 1992)
- Because of privacy implications, these systems have had mixed success.
- The places in which this succeeds are those in which the individuals seem to have a reciprocal need to be aware of each other's presence, and a sense of cooperation and coordination

Awareness (2/2)

- Instant messaging systems provide an awareness capability
  - Most systems display a list of “buddies” and whether they are currently on-line or not
  - Nardi et al. (2000) found that people liked this aspect of IM
- Since wireless has allowed constant connectivity of mobile devices, this use of tracking others is likely to grow
- There are issues of monitoring for useful or insidious purposes, and the issues of trust and privacy loom large
- Studies of attempts to carry out difficult intellectual work within geographically distributed organizations show that one of the larger costs of geographical distribution is the lack of awareness of what others are doing or whether they are even around
- Thus, useful and usable awareness tools that mesh well with trust and privacy concerns could be of enormous organizational importance

Interruptions

- A related problem that has recently received much attention is the matter of interruptions. Interruptions have the property that there is an asymmetry between the interrupter and the interrupted, that the former seemingly has more control over the occasions of the interruption than the latter (Nardi and Whitaker, 2000)
  - Though one interesting find is that in the normal course of activity, many interruptions are self-administered (Mark et al 2005)
- These issues become more acute in distributed work, especially with weak awareness support. Given this, several investigators have explored with some success whether techniques drawn from statistical decision theory or machine learning could be used to figure out from sensor data whether a person is interruptible

Information repositories

Repositories of shared knowledge (1/2)

- Information repositories provide a way to share information
- The goal in most systems is to capture knowledge that can be reused by others
  - like instruction manuals, office procedures, training, and "boilerplates," or templates of commonly constructed genres, like proposals or bids
- The web provides infrastructure for the creation and sharing of information repositories
- A variety of tools are appearing to support this
  - Of particular interest are open source tools that allow for a wider, more flexible infrastructure for supporting information sharing
  - A major type of collaboratory (more later) are those that provide shared data repositories for a community of scientists

Repositories of shared knowledge (2/2)

- Experience shows, however, that these systems are not easy wins
- Similar to the case of the on-line calendaring systems described above, the person entering information into the system is not necessarily the one benefiting from it
  - In a large consulting firm, where consultants were quite competitive in their bid for advancement, there was indeed negative incentive for giving away one's best secrets and insights (Orlikowski & Gash, 1994)
- Sometimes subtle design features are at work in the incentive structure
  - In another adoption of Lotus Notes, in this case to track open issues in software engineering, the engineers slowly lost interest in the system because they assumed that their manager was not paying attention to their contributions and use of the system
  - The system design, unfortunately, made the manager's actual use invisible to the team
  - Had they known that he was reading daily what they wrote (though he never wrote anything himself), they would likely have continued to use the system (Olson et al., 1996)
  - A simple design change that would make the manager's reading activity visible to the team would likely have significantly altered their adoption

Wikis

- A wiki is a shared web space that can be edited by anyone who has access to it. They were first introduced by Ward Cunningham in 1995
  - These can be used in a variety of ways, both for work and for fun
- The most famous wiki is Wikipedia (www.wikipedia.org), an online encyclopedia where anyone can generate and edit content
- It has grown to have millions of entries, and has versions in tens of languages
  - A recent study carried out by *Nature* found that for science articles Wikipedia and the Encyclopedia Britannica were about equally accurate (Giles, 2005).
  - Bryant, Forte, and Bruckman (2005) studied the contributors to Wikipedia, and suggested that a new publishing paradigm was emerging
  - Viegas, Wattenberg, and Dave (2004) developed imaginative visualizations of Wikipedia authoring and editing behavior over time
  - Other topics include information reliability, contributor reliability, incentive systems, image contribution, and Wikipedia administration
- While an extensive literature on Wikipedia has developed in recent years, a paper by Kittur and Kraut (2010) looks into 7000 other wikis, noting both similarities and differences with the findings that have emerged from studies of Wikipedia
  - For instance, coordination mechanisms across a wide range of wikis tended to be similar with Wikipedia. But a wide range of policies, procedures and other mechanisms for managing a wiki appeared in the larger sample

Capture and Replay

- Tools that support collaborative activity can create traces of that activity that later can be replayed and reflected upon
  - The Upper Atmospheric Research Collaboratory (UARC) explored the replay of earlier scientific campaign sessions (Olson et al., 2001), so that scientists could reflect upon their reactions to real-time observations of earlier phenomena.
    - Using a VCR metaphor, they could pause where needed, and fast forward past uninteresting parts. This reflective activity could also engage new players who had not been part of the original session
  - Abowd (1999) has explored such capture phenomena in an educational experiment called Classroom 2000
    - Initial experiments focused on reusing educational sessions during the term in college courses
  - Lipford and Abowd (2008) report the long-term deployment of such a system, noting a number of challenges in making such systems effective
- The impact of such promising ideas is not yet fully understood

Social Computing

Trust of people via the technology

- It has been said that “trust needs touch,” and indeed in survey studies, coworkers report that they trust those who are collocated more than those who are remote (Rocco et al, 2000)
- Interestingly, those who spend the most time on the phone chatting about non-work related topics with their remote coworkers show higher trust than those they communicate with using only fax and e-mail
- But lab studies show that telephone interaction is not as good as face-to-face
- People using just the telephone behave in more self-serving, less-trusting ways than they do when they meet face to face (Drolet & Morris, 2000)

Counteracting mistrust

- Rocco (1998) had people meet and do a team-building exercise the day before they engaged in the social dilemma game with only e-mail to communicate with
- These people, happily, showed as much cooperation and trust as those who discussed things face to face during the game
- This suggests that if remote teams can do some face-to-face teambuilding before launching on their project, they will act in a trusting/trustworthy manner.
- Since it's not always possible to have everyone on a project meet face to face before they launch into the work, researchers have tried some options, but with mixed success
  - Zheng, Bos, Olson, Gergle, and Olson (2001) found that using chat for socializing and sharing pictures of each other also led to trustful relations. Merely sharing a resume did not

Trust: Text vs voice vs video

- When the text is translated into voice, it has no effect on trust, and when it is translated into voice and presented in a moving human-like face, it is even worse than text-chat
  - However, Bos et al (2001) found that interactions over video and audio led to trust, albeit of a seemingly more fragile form
- In other tasks, video does not produce "being there"
  - There is an overhead to the conversation through video; it requires more effort than working face to face (Olson et al., 1995)
  - When videos over the Internet are both delayed and choppy, they produce cues that people often associate with lying

Integrated Systems

Media Spaces

- As an extension of video conferencing and awareness systems, some people have experimented with open, continuous audio and video connections between remote locations
- In a number of cases, these experiments have been called "Media Spaces"
  - For example, at Xerox, two labs were linked with an open video link between two commons areas (Olson & Bly, 1991), the two locations being Palo Alto, California, and Portland, Oregon
- Evaluation of these experiments showed that maintaining organizational cohesiveness at a distance was much more difficult than when members are collocated but some connectedness was maintained
- Where many of these early systems were plagued with technical difficulties, human factors limitations, or very large communication costs, in today's situation it might actually be possible to overcome these difficulties, making media a possibility for connecting global organizations
- A new round of experimental deployments with new tools is needed

Collaborative virtual environments (1/3)

- Collaborative virtual environments are 3D embodiments of multi-user domains (MUDs)
- Similar to MUDs, the users in a meeting situation might interact over some object that is digitally represented, like a mock up of a real thing (e.g., an automobile engine, an airplane hinge, a piece of industrial equipment) or with visualizations of abstract data (e.g., a 3D visualization of atmospheric data)
- In these spaces, one can have a sense as to where others are and what they are doing, similar to the simplified awareness systems described above
- In use, it is difficult to establish mutual awareness or orientation in such spaces
- There have even been some attempts to merge collaborative virtual environments with real ones, though with limited success so far

Collaborative virtual environments (2/3)

- The emergence of multiplayer games with rich virtual environments has literally exploded in the past years
- There is growing literature on the characteristics of play and collaboration in these games
  - Ducheneaut and Moore (2005) described the learning of social skills in such games
  - Brown and Thomas (2006) speculated that achieving mastery in such collaborative games might become an important entry on a resume
  - Bainbridge (2007) discussed the scientific research potential of such worlds
  - Nardi (2010) summarized her extensive experience in playing World of Warcraft

Collaborative virtual environments (3/3)

- Another recent development is the emergence of virtual environments like Second Life
- These are not game environments but a platform in which a wide range of social phenomena are supported in a virtual world
  - Many colleges and universities have a presence in Second Life and have engaged in creative activities such as prototyping future places (e.g., hotel designs) or software
- Interest in multi-user simulations and virtual worlds has waxed and waned
  - Second Life attracted attention in the late 2000s. World of Warcraft is a gaming success
- Dramatic high-end uses of technology that have appeared in theme parks are strong indications that compelling, fully immersive digital environments are possible and will eventually be affordably priced

Collaboratories (1/2)

- A collaboratory is a laboratory without walls (Finholt & Olson, 1997)
- A collaborator is supposed to allow "the nation's researchers [to] perform their research without regard to geographical location—interacting with colleagues, accessing instrumentation, sharing data and computational resources [and] accessing information in digital libraries" (National Research Council, 1993, p. 7)
- Starting in the early 1990s, these capabilities have been configured into support packages for a number of specific sciences
- The Science of Collaboratories project has identified more than 200 existing collaboratories and is drawing lessons about why some succeed and others don't (Olson et al., 2004)

Collaboratories (2/2)

- A number of companies have also experimented with similar concepts, calling them “virtual collocation”
  - The goal there is to support geographically dispersed teams as they carry out product design, software engineering, financial reporting, and almost any business function
- In these cases, suites of off-the-shelf groupware tools have been particularly important and have been used to support round-the-clock software development among overlapping teams of engineers in time zones around the world (Carmel, 1999)
- There have been a number of such efforts, and it is still unclear as to their success or what features make their success more likely
  - Possible factors have been summarized in Olson et al. (2008)

Examples (1/3)

- Team workspaces such as Microsoft's SharePoint or Google Wave (see figure) provide a managed repository for a team's artifacts and tools for communicating and sharing information with one another

Examples (2/3)

- Social networking also enables a new generation of coordination technologies whether mobile and location-aware real-time
  - (e.g., Foursquare and Google Latitude - figure - or asynchronous - e.g., Groupon's coordination of purchasing decisions)

Examples (3/3)

- Group meeting in Second Life (2010)

A framework for team behaviour (1/4)

Easily overlooked

	Production	Group well-being	Member support
Inception	Production demand and opportunity	Interaction demand and opportunity	Inclusion demand and opportunity
Problem-solving	Technical problem solving	Role network definition	Position and status achievements
Conflict resolution	Policy resolution	Power and payoff distribution	Contribution and payoff distribution
Execution	Performance	Interaction	Participation

Principle focus of attention

- Joseph McGrath's (McGrath 1991) framework characterizes team behavior in terms of three functions (production, group well being, and member support) and four modes (inception, problem solving, conflict resolution, and execution)

A framework for team behaviour (2/4)

- The key to understanding the framework's utility is to focus on the columns
- Organizations are obsessed with demonstrating that a new technology or process yields a "return on investment," measured as increased performance:
  - the lower left cell, the production function and the execution mode
- This apparently logical goal has two significant drawbacks:
  - It is often impossible to prove that a communication or collaboration tool yields positive performance effects in real-world settings, so much time and money is squandered in futility. Lab studies of technology use overwhelmingly focus on impacts in the lower left cell
  - Second, with a laser focus on performance, it is easy to overlook that positive or negative impacts in other cells can have crucial indirect consequences
  - For example, no one could prove a productivity benefit for email
    - Eventually people stopped questioning it

A framework for team behaviour (3/4)

- On the other hand, group support systems (electronic meeting rooms, a major focus of research in the 1980s and commercialization attempts in the 1990s) did well in controlled studies but were never commercially successful
- Why? An analysis by Dennis and Reinicke (2004) attributes this to the lack of support for group well-being and member support
  - One participant in a meeting conducted using a group support system said that it was the most unpleasant meeting he had experienced in his life, despite its success at accomplishing its stated objective

A framework for team behaviour (4/4)

- Some technologies that show no positive effects in lab studies that focus on performance can provide benefits in other cells
- They can aid in conflict resolution or problem-solving, enable people to achieve recognition or status, and so on
  - E.g., videoconferencing can have subtle effects that are difficult to measure in terms of return on investment:
    - It can assist conflict-resolution or problem-solving (Williams, 1997), and if people like it, it could strengthen group ties

Organizational behavior and support (1/2)

- People in different parts of an organization often respond very differently to the same application (Perin, 1991; Grudin, 2004)
- Mintzberg (1984) identifies the major parts of an organization
  1. the executives (strategic apex)
  2. managers (middle line)
  3. individual contributors (operating core)
  4. the people formulating work processes (technostructure)
  5. the support staff
- People in each of these five areas work and use technology differently

Organizational behavior and support (2/2)

- Individual contributors
  - Often communicate extensively and informally with one another
  - They also have few meetings, cannot delegate work, and their work activity is visible to others in the organization
- Managers
  - Sharing structured information in documents, spreadsheets, and slide decks is a high priority
  - They also have many meetings, can delegate some work, and face a trade-off between the sensitivity of some tasks and the efficiency gained by informing others of their status.
- Executives
  - coordinate activities of different groups
  - They are also constantly in meetings, delegate tasks, and their meeting schedules are sensitive
- Improving performance, the production-execution cell in McGrath's framework, requires different technologies and patterns of use in different parts of an organization
- For any technology used by all employees, Mintzberg's groups differ in the features that they appreciate and those that they dislike

Challenges and Opportunities

- Introducing a new technology is initially disruptive; it requires a leap of faith to believe that eventually greater efficiency or effectiveness will result
- In addition, we are social beings, with preferred ways of interacting represented in our genes and in social conventions developed over a long time
- We are not always consciously aware of them, but a technology that violates them is unlikely to succeed

Eight design and adoption challenges (1/5)

1. Disparities in effort required and benefits for individuals
   - When a technology requires that some of its users perform additional work without a compensating benefit, adoption may not follow
2. Limits of informed intuition: Managers & designers beware
   - A corollary is that a decision about which technology to research, develop, or deploy is generally based on the intuitions of managers who may not appreciate how the technology will be received by other group members

Eight design and adoption challenges (2/5)

3. Achieving Critical Mass and avoiding Prisoner's Dilemma
   - A collaboration tool may not achieve the necessary critical mass of users
   - For example, one of the most actively researched CSCW applications was desktop videoconferencing; generally only some people had video, but everyone could be reached by telephone. (The converse problem is the tragedy of the commons: a technology may cease to be useful if too many people embrace it.)
   - More insidious is the prisoner's dilemma: If everyone looks to their own best interest, perhaps by free-riding on the efforts of others, then outcomes deteriorate and use may collapse altogether

Eight design and adoption challenges (3/5)

4. Avoiding other social & motivational pitfalls
   - Adverse social and motivational effects can result when a new tool disrupts existing channels, creates uncertainty about where to find information, and challenges existing authority structures
   - For example, executives who adopt a communication tool that enables them to interact directly may find that their administrators, now out of the loop, are less effective at managing their schedules and anticipating events

Eight design and adoption challenges (4/5)

5. Exception-handling: The bane of workflow & other systems
   - A major contribution from ethnographic studies is the observation that group behavior often focuses on handling exceptions or unanticipated events
   - Technologies designed to coordinate work activities often incorporate and enforce models of standard work processes and cannot gracefully handle deviations from such models

Eight design and adoption challenges (5/5)

6. Designing for low-frequency events
   - Collaborative features often must paradoxically be unobtrusive, because they are often used less frequently than other features, yet readily accessible when needed
7. The difficulty of evaluation
   - In addition, these technologies can be very difficult to evaluate...
8. Designing with an adoption process in mind
   - ...and adopt. Designers must consider what will be needed to promote successful adoption from the outset

Eight design and adoption challenges - progress

- This list of challenges from 1994 (Grudin) is among the most cited topics in CSCW, an indication that these are stubborn challenges
- There has been progress:
  - Palen and Grudin (2002) in a follow-up study of the adoption of group calendars found that organizational conditions in the 1990s were much more favorable for the adoption of group tools than they were in the 1980s
  - The tools themselves had improved in reliability, functionality and usability
  - There is increased “collaboration readiness” and “collaboration technology readiness” that has made for increased success of such applications
  - The very rapid take-up of technologies like Wikipedia, Facebook, Twitter and multiplayer games is testament to the changed circumstances in current times
  - Items 5 and 6 in Grudin’s list are certainly not as much of a challenge at present
  - Many of the others persist as serious challenges

Future Directions

- Moore's law has not been revoked. Smaller sensors and effectors, larger displays, better networking, and powerful visualizations will drive innovation and open design opportunities
- The single largest issue that we are likely to contend with, as individuals, organizations, and societies for a very long time, is how to deal with transparency
  - Once information is digital it can show up anywhere at any time in the future, and much more is represented digitally every minute of every day.
  - In this way, we learn that people do not behave as we thought they did or believe they should, people do not follow policies, regulations, or laws as closely as we imagined, social conventions are not honored consistently, and violations of all of these are prosecuted unevenly. We see chaos, inconsistency, and fallibility that was always present but not revealed. How will we react? Formulate more nuanced rules, enforce them more strictly, or become more tolerant of deviation?

The End

References

- **Jacko, J. A. (Ed.). (2012). Human Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications. CRC press.**
  - Olson, G., Olson, J. (2012). Collaborative technologies. pp- 545-563
- Grudin, J., & Poltrock, S. (2013). Computer supported cooperative work. The Encyclopedia of Human-Computer Interaction, 2nd Ed.
- Grudin, J. (1994). Groupware and social dynamics: Eight challenges for developers. Communications of the ACM, 37(1), 92-105.
- McGrath, J. E. (1991). Time, interaction, and performance (TIP) A Theory of Groups. Small group research, 22(2), 147-174.
- Mintzberg, H. (1984). Power and organization life cycles. Academy of Management review, 9(2), 207-224.
- Palen, L., & Grudin, J. (2002). Discretionary adoption of group support software: lessons from calendar applications. In B. E. Munkvold (Ed.), Implementing collaboration technologies in industry (pp. 159–180). Springer-Verlag. London.
- Wilson, P. (1991). Computer supported cooperative work: An introduction. Springer Science & Business Media.

Additional References

- Abowd, G. D. (1999). Classroom 2000: An experiment with the instrumentation of a living educational environment. IBM Systems Journal, 38, 508–530.
- Bainbridge, W. S. (2007). The scientific research potential of virtual worlds. science, 317(5837), 472-476.
- Bellotti, V., & Dourish, P. (1997). Rant and RAVE: Experimental and experiential accounts of a media space. In K. E. Finn, A. J. Sellen, & S. B. Wilbur (Eds.), Video-mediated communication (pp. 245–272). Mahwah, NJ: Lawrence Erlbaum Associates.
- Bos, N., Gergle, D., Olson, J. S., & Olson, G. M. (2001). Being there vs. seeing there: trust via video. Short Paper presented at the Conference on Human Factors in Computing Systems: CHI-2001. Seatle, WA.
- Brown, J.S., and Thomas, D. (2006). You play World of Warcraft? You're hired. Wired Magazine, 14(4)
- Bryant, S. L., Forte, A., & Bruckman, A. (2005). Becoming Wikipedian: Transformation of participation in a collaborative online encyclopedia. Proceedings of GROUP 2005 (pp. 1–10). New York: ACM.
- Carmel, E. (1999). Global software teams. Upper Saddle River, NJ: Prentice-Hall.
- Cosley, D., Frankowski, D., Kiesler, S., Terveen, L., & Riedl, J. (2005). How oversight improves member-maintained communities. Proceedings of CHI 2005 (pp. 11–20). New York: ACM.
- Dennis, A. R., & Reinicke, B. A. (2004). Beta versus VHS and the acceptance of electronic brainstorming technology. Mis Quarterly, 1-20.
- Dourish, P., & Bly, S. (1992). Portholes: Supporting awareness in a distributed work group. Proceedings of CHI 92 (pp.
- Drolet, A. L. & Morris, M. W. (2000). Rapport in conflict resolution: Accounting for how nonverbal exchange fosters coordination on mutually beneficial settlements to mixed motive conflicts. Journal of Experimental Social Psychology, 36(1), 26–50.
- Ducheneaut, N., & Moore, R. J. (2005). More than just'XP': Learning social skills in massively multiplayer online games. Interactive Technology and Smart Education, 2(2), 89-100.

Additional References

- Ellis, C. A., Gibbs, S. J., & Rein, G. L. (1991). Groupware: Some issues and experiences, CACM, 34(1), 38–58.
- Elrod, S., Bruce, R., Gold, R., Goldberg, D., Halasz, F., Janssen, W., Lee, D., McCall, K., Pedersen, E., Pier, K, Tang, J., & Welch, B. (1992). LiveBoard: A large interactive display supporting group meetings, presentations, and remote collaboration. Proceedings of CHI'92
- Engelbart, D., & English, W. (1968). A research center for augmenting human intellect. Proceedings of FJCC, 33, 395–410.
- Finholt, T. A., & Olson, G. M. (1997). From laboratories to collaboratories: A new organizational form for scientific collaboration. Psychological Science, 8, 28–36.
- Fish, R. S., Kraut, R. E., Root, R. W., & Rice, R. E. (1993). Video as a technology for informal communication. Communications of the ACM, 36(1), 48–61.
- Fussell, S. R., Kraut, R. E., & Siegel, J. (2000). Coordination of communication: Effects of shared visual context on collaborative work. Paper presented at the CSCW 2000, New York.
- Giles, J. (2005). Internet encyclopaedias go head to head. Nature, 438, 900–901.
- Greif, I. (Ed.) (1988). Computer-supported cooperative work: A book of readings. San Mateo, CA: Morgan Kaufmann.
- Grudin, J. (2004, November). Return on investment and organizational adoption. In Proceedings of the 2004 ACM conference on Computer supported cooperative work (pp. 324-327). ACM.

Additional References

- Herlocker, J. L., Konstan, J. A., & Riedl, J. (2000). Explaining collaborative filtering recommendations. Proceedings of CSCW 2000 (pp. 241–250). New York: ACM.
- Huang, W., Olson, J. S., & Olson, G. M. (2002). Camera angle affects dominance in video-mediated communication. Paper presented at the CHI 2002, New York.3
- Isaacs, E., Walendowski, A., Whittaker, S., Schiano, D. J., & Kamm, C. (2002). The character, functions, and styles of instant messaging in the workplace. Paper presented at the CSCW 2002, New York
- Karsenty, L. (1999). Cooperative work and shared visual context: An empirical study of comprehension problems in side-by-side and remote help dialogues. Human-Computer Interaction, 14, 283–315.
- Kiesler, S., & Cummings, J. N. (2002). What do we know about proximity and distance in work groups? A legacy of research. In P. J. Hinds & S. Kiesler (Eds.), Distributed work (pp. 57–80). Cambridge, MA: MIT Press.
- Kittur, A., & Kraut, R. E. (2010, February). Beyond Wikipedia: coordination and conflict in online production groups. In Proceedings of the 2010 ACM conference on Computer supported cooperative work (pp. 215-224). ACM.
- Kraut, R. E., Fussell, S. R., & Siegel, J. (2003). Visual information as a conversational resource in collaborative physical tasks. Human-Computer Interaction, 18(1–2), 13–39.
- Kraut, R. E., Gergle, D., & Fussell, S. R. (2002). The use of visual information in shared visual spaces: Informing the development of virtual co-presence. Paper presented at the CSCW 2002, New York.
- Lipford, H. R., & Abowd, G. D. (2008). Reviewing meetings in teamspace. Human–Computer Interaction, 23(4), 406-432.
- Luff, P., Heath, C., Kuzuoka, H., Hindmarsh, J., & Oyama, S. (2003). Fractured ecologies: Creating environments for collaboration. Human-Computer Interaction, 18(1–2), 51–84.

Additional References

- Mark, G. J., Al-Ani, B., & Semaan, B. (2009, April). Resilience through technology adoption: merging the old and the new in Iraq. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 689-698). ACM.
- Moran, T. P., Chiu, P., Harrison, S., Kurtenbach, G., Minneman, S., & van Melle, W. (1996). Evolutionary engagement in an ongoing collaborative work process: A case study. Proceeding of the ACM Conference on Computer Supported Cooperative Work (pp. 150–159). Cambridge, MA: ACM Press.
- Muller, M. J., Raven, M. E., Kogan, S., Millen, D. R., & Carey, K. (2003). Introducing chat into business organizations: Toward an instant messaging maturity model. Paper presented at the GROUP '03, New York.
- Nardi, B. A., Schwarz, H., Kuchinsky, A., Leichner, R., Whittaker, S., & Sclabassi, R. (1993). Turning away from talking heads: the use of video-as-data in neurosurgery. Paper presented at the CHI 93, New York.
- Nardi, B. A., Whittaker, S., & Bradner, E. (2000). Interaction and outeraction: Instant messaging in action. Proceedings of the ACM Conference on Computer Supported Cooperative Work (pp. 79–88). Philadelphia, PA: ACM Press
- Nardi, B. (2010). My life as a night elf priest: An anthropological account of World of Warcraft. University of Michigan Press.
- National Research Council. (1993). National collaboratories: Applying information technology for scientific research. Washington, D.C.: National Academy Press.
- Nunamaker, J. F., Dennis, A. R., Valacich, J. S., Vogel, D. R., & George, J. F. (1991). Electronic meeting systems to support group work. Communications of the ACM, 34(7), 40–61.

Additional References

- Olson, M. H., & Bly, S. A. (1991). The Portland experience: A report on a distributed research group. International Journal of Man- Machine Studies, 34, 211–228.
- Olson, J. S., Olson, G. M., Storrøsten, M., & Carter, M. (1993). Group work close up: A comparison of the group design process with and without a simple group editor. ACM Transactions on Information Systems, 11, 321–348.
- Olson, J. S., Olson, G. M., & Meader, D.K. (1995). What mix of video and audio is useful for remote real-time work? Proceedings of CHI '95 (pp. 362–368). Denver, CO: ACM Press.
- Olson, J. S., & Teasley, S. (1996). Groupware in the wild: Lessons learned from a year of virtual collocation. Proceeding of the ACM Conference on Computer Supported Cooperative Work (pp. 419–427). Cambridge, MA: ACM Press.
- Olson, G. M., Atkins, D., Clauer, R., Weymouth, T., Prakash, A., Finholt, T., Jahanian, F., & Rasmussen, C. (2001). Technology to support distributed team science: The first phase of the Upper Atmospheric Research Collaboratory (UARC) In G. M. Olson, T. Malone, & J. Smith (Eds.), Coordination theory and collaboration technology (pp. 761–783). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Olson, G. M., Olson, J. S., Bos, N., & the SOC Data Team (2004). International collaborative science on the net. In W. Blanpied (Ed.), Proceedings of the Trilateral Seminar on Science, Society and the Internet (pp. 65–77). Arlington, VA: George Mason Univeristy
- Olson, J. S., E. C. Hofer, N. Bos, A. Zimmermann, G. M. Olson, D. Cooney, and I. Faniel (2008). A theory of remote scientific collaboration (TORSC). In Scientific Collaboration on the Internet, ed. G. M. Olson, A. Zimmermann, & N. Bos. Cambridge, MA: MIT Press.
- Orlikowski, W. J., & Gash, D. C. (1994). Technological frames: Making sense of information technology in organizations. ACM Transactions on Information Systems, 12, 174–207.
- Palen, L., Vieweg, S., Liu, S. B., & Hughes, A. L. (2009). Crisis in a networked world features of computer-mediated communication in the April 16, 2007, Virginia Tech Event. Social Science Computer Review, 27(4), 467-480.
- Robertson, G., Czerwinski, M., Baudisch, P., Meyers, B., Robbins, D., Smith, G., & Tan, D. (2005). The large-display user experience. Computer Graphics and Applications, IEEE, 25(4), 44-51.

Additional References

- Perin, C. (1991). Electronic social fields in bureaucracies. Communications of the ACM, 34(12), 75-82.
- Rocco, E. (1998) Trust breaks down in electronic contexts but can be repaired by some initial face-to-face contact. Proceedings of CHI'98 (pp. 496–502). Los Angeles, CA: ACM Press.
- Rocco, E., Finholt, T., Hofer, E. C., & Herbsleb (2000). Designing as if trust mattered. (CREW Technical Report). University of Michigan, Ann Arbor.
- Schafer, J. B., Konstan, J., & Riedl, J., (2001). Electronic commerce recommender applications. Journal of Data Mining and Knowledge Discovery, 5(1/2), 115–152.
- Schafer, W. A., Ganoe, C. H., & Carroll, J. M. (2007). Supporting community emergency management planning through a geocollaboration software architecture. Computer Supported Cooperative Work (CSCW), 16(4-5), 501-537.
- Schmidt, K. 2010. 'Keep up the good work!': The concepts of 'work' in CSCW. In Proceedings of COOP 2010, 265-85. London: Springer-Verlag.
- Teasley, S. D., Covi, L. A., Krishnan, M .S., & Olson, J. S. (2002). Rapid software development through team collocation. IEEE Transactions on Software Egnineering, 28, 671–683.
- Viegas, F. B., Wattenberg, M., & Dave, K. (2004). Studying cooperation and conflict between authors with history flow visualizations. Proceedings of CHI 2004 (pp. 575–582). New York: ACM.
- Vieweg, S., Hughes, A. L., Starbird, K., & Palen, L. (2010, April). Microblogging during two natural hazards events: what twitter may contribute to situational awareness. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 1079-1088). ACM.
- Whittaker, S., Geelhoed, E., & Robinson, E. (1993). Shared workspaces: How do they work and when are they useful? International Journal of Man-Machine Studies, 39(5), 813–842.
- Whittaker, S. (2005). Supporting collaborative task management in e-mail. Human-Computer Interaction, 20, 49–88.
- Zheng, J., Bos, N., Olson, J. S., Gergle, D. & Olson, G. M. (2001). Trust without touch: Jump-start trust with social chat. Paper presented at the Conference on Human Factors in Computing Systems CHI-01. Seatle, WA: ACM Press