Group Dynamics and Ubiquitous Computing:  
From “Here and Now” to “Everywhere and Forever”  

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The vision of ubiquitous computing [10] has centered on potential benefits of widely distributed input and output devices — sensors, effectors, and displays that may be carried, worn, or embedded in the environment. These will benefit us as individuals. Social implications are acknowledged but rarely considered carefully. In this article I focus on group interaction in this new world. In doing so the technology focus shifts to the vast network that will link these individually modest devices and to the rapidly growing digital repositories distributed across that network.

Human nature changes very little. Whether its constancy is viewed as reassuring or as a cause for concern, technology design is constrained by our innate capabilities and limitations. These innate characteristics are social as well as perceptual and cognitive. Humans have lived in groups for millions of years and social behaviors have been central to survival: Group interaction skills are part of our nature. In contrast, we are not designed to function in the organizations, nations, and other large-scale aggregations that only emerged when consistent temperate climates permitted the expansion of agriculture over the past 10,000 years.

We accept that technology must accommodate human perceptual and motor limitations. Less evident is the fact that, because group dynamics are also ingrained in human nature, unsusceptible to change and inaccessible to conscious awareness, technology must also accommodate the way we naturally interact. It is not readily apparent how to make this happen. This may contribute to the slow uptake of many forms of groupware. In contrast, because organizational dynamics are not integral to our nature, technology use, like management practice, can be more improvisational at that level.

Technology and Groups

Digital technology designed to support group interaction falls loosely into three phases: pre-ubiquitous support for face to face meetings (beginning around 1970), proto-ubiquitous support for distributed meetings (beginning in earnest around 1990 although visionary demonstrations appeared earlier), and ubiquitous support for activity in distributed locations over time, now getting underway. Here, I review discoveries from the first two phases that provide insight into the immutable aspects of group dynamics with which ubiquitous technology must coexist.

**Pre-ubiquity: face to face meeting support.** For millions of years, our ancestors interacted directly. Complex social and emotional behaviors evolved that are tuned to this context. “Same-time, same-place” technology support appeared as early as 1971 [3]. Tools for brainstorming, idea organizing, and voting were refined over two decades. Electronic meeting room successes included a widely-publicized study that showed a 90% reduction in project time [8]. Three companies marketed products in the early 1990s. None did
well. The Fortune 500 company that reported a 90% saving discontinued use of their system.

A wake-up call: In 1990, the Institute for the Future convened a group of experts to discuss the future of groupware. They used a commercial electronic meeting room system for the day-long exercise, heralding its efficiency. In 2001, IFF again convened experts. No digital technology was used—instead, markers, paper, and colored tags were used to record, distribute, and endorse ideas.

Technology can support meetings effectively: blackboards, flipcharts, microphones, overhead projectors, and slides. The benefits may not always be great—presentation experts discourage its use, arguing that effective speakers should draw audience attention to themselves—as speakers have done since pre-history. Even when a digital system does increase productivity, meetings are complex social spaces that must also address other concerns, notably group cohesion and member well-being [5]. Establishing and maintaining status, process, and morale can be as important as productivity. For example, a meeting was stopped by an executive when no one would confess to having typed a critique that was displayed anonymously by software that supports brainstorming [7]. This illustrates that status and process concerns can outweigh immediate productivity goals.

A related reason we are reluctant to adopt new meeting support technologies is that unlike with a personal productivity tool, experimentation occurs in public. We learn by making mistakes, but mistakes in this domain are often embarrassing. To avoid problems, the use of trained facilitators and technology experts is recommended, but they divert attention from the meeting “owner.” Process and status are altered.

We complain about meetings and realize that some could be more effective, but on the whole we are experienced with and comfortable with meetings. Support technologies that have succeeded (blackboards…) are those that minimally alter the social dynamics. The message for ubiquitous computing is that these technologies, too, must meld with human social dynamics. They should not focus exclusively on improving productivity if this requires us to change fundamental aspects of how we interact.

Proto-ubiquity: distributed meeting support. Consider a relatively simple technology enhancement: two distant conference rooms linked by a microphone on each table and a camera and monitor at one end of each room. Without the system, the person at the head of the table (the organizer) is the center of attention and people less interested in the meeting topic sit at the far edges. With the technology in place, the bored people loom largest in the camera view, the distant organizer is most difficult to discern. Attention in the room leaves the organizer and focuses on the monitor, making the organizer uncomfortable. When the organizer addresses remote participants, visible as small images across the room, the natural tendency is to raise the voice, which microphone placement translates into shouting. Lighting is difficult: Distant participants often appear washed out, ill, even more so if the video is delayed or jerky. The net effect on remote participants—being shouted at by a small, expressionless person who looks ill and is
surrounded by inattentive colleagues – may not stop work from getting done, but can unconsciously undermine the experience, team cohesion and morale. And this is a scenario involving a *simple* technology intervention.

Real-time distributed communication has been examined, often in two- and three-person groups, sometimes in the field [4]. These studies indicate that participants in distributed meetings lack important contextual information that is present in face to face meetings: knowledge of who is coming and going at remote sites, how people are reacting, what objects are around them, what they are paying attention to, and so forth. Seemingly small things make a difference, such as whether remote participants are seated in an auditorium or crowded in an office, have full- or half-duplex audio, or have a fax machine or computer nearby. The importance of audio quality is often underestimated even by participants themselves. For example, if everyone at one site laughs at a side comment that could only be heard in the room, distant participants are not in on the joke and may wonder whether they were its target, since in a face to face meeting people lower their voices precisely to avoid being overheard.

The fact that participants in distributed meetings are actively (though perhaps unconsciously) seeking contextual information is an opportunity for ubiquitous computing. If we identify the missing information, sensors may be able to deliver it. But there are challenges. Identifying the important contextual elements may be difficult. When we succeed, how do we then deliver it in a manner that can be apprehended as easily and accurately as in person, given that our sensory and social skills have evolved for millions of years to do the latter effectively? The evidence suggests that this is difficult. For example, people effortlessly signal emotion through facial expression, body posture, and gesture. “Emoticons” and “mood indicators” don’t work nearly as effectively.

Another challenge is that representing contextual information digitally transforms it in several ways [2]. Most radically, once on a network, information cannot be controlled. Gestures, expressions, and words in a face to face meeting are ephemeral. But once on a network, contextual information could reappear anywhere on the planet, at any time in the future. This aspect of ubiquitous computing is explored below.

*Asynchronous group support: the realm of ubiquitous computing.* Group activity that is distributed in time and space includes individual activities that must be coordinated, informal and formal communication, and information sharing. As computing diffuses throughout our environment, all of these could be supported. To identify opportunities and challenges, let’s first consider the record of success and failure.

Personal productivity tools are a major success of computing. These tools have been improved by adapting them to innate human perceptual and cognitive characteristics. Efforts to coordinate individual work have been far less successful. The dozens of workflow management products, similar to their office automation predecessors of the 1970s, are appealing in concept but not successful in practice, arguably because they have not accommodated the flexible ways people work together.
In contrast, many communication and information sharing tools have succeeded, especially those that resemble pre-existing approaches. Email and instant messaging are similar to conversing; attachments resemble objects handed to people. However, digital representation alters them, and the changes have interesting consequences. Unlike conversation, email and online messages do not disappear as they are consumed, they are not reliably ephemeral. Attachments can be distributed effortlessly, unlike physical objects.

Ubiquitous computing encompasses efforts to record and archive formal meetings and spontaneous interactions for subsequent review or viewing by those not present [1, 6]. Distributing information in time and place is the intent, not a byproduct, of the digital representation of sensor data. There may be an intended audience for the information, but no guarantee that it will not spread more widely. Digital rights management efforts, if successful, might impede but probably could not prevent the spread of digital information.

From “here and now” to “everywhere and forever”
Masanao Toda [9] describes the context in which our social behaviors evolved and for which they are adapted. In the wilderness of pre-history, opportunities and challenges were faced directly. Anger, empathy, fear, desire, sadness, joy—all were reactions to objects, events, actions, or people in the immediate vicinity. Social relations and social status were established and maintained in face-to-face settings. These urges and activities became part of our nature because they were effective in such environments.

Toda notes that when larger-scale social organization appeared, for the first time people were often affected by actions that took place not “here and now,” but in distant locations and some time before. These distant events have real consequences. They trigger the urges and emotions that were designed for the immediacy of the wilderness state, but the pertinent objects and people are no longer present. Our reactions cannot be suppressed—it is human nature—but they are often inappropriate, as in the familiar movie scene in which a person hears bad news and slams a fist into the wall. Over the past ten thousand years we have explored ways to control or channel these urges in our less localized organizations and societies.

Memory and storytelling allowed limited excursions in time and place. But technologies have steadily separated us from the things that affect us: transportation, writing and printing, telegraph and telephone, radio and television. Through them we are affected by past and distant actions of others, and our own actions have echoes that we do not hear.

Ubiquitous computing is the ultimate cleavage of action from “the here and now.” Once a digital representation of an action reaches a network, it could surface anywhere on the planet at any future time. It might not reappear, but it might. As a result, we never know the contexts in which we act. A high school student may create a web page to be viewed by other students and ten years later find that it is being viewed by prospective employers. Understanding our context-dependent social behaviors, designed through
natural selection, is crucial in identifying the limits, opportunities, and risks of context-traversing digital technologies.

When digital information appears in places not originally envisioned, it is unclear how it will be interpreted. Online publication of prisoners being paroled lacks the background information that went into the parole decisions; online access to malpractice histories does not reveal which medical specialties are most at risk; private email surfaces in public court cases where the workplace vocabulary and style are not understood; remarks are made to a small newsgroup that the writer never imagined would be read by colleagues; comments in a graduate student’s web page torpedo her subsequent application for a faculty position; a review written for people who had read a paper are made available to a whole committee; and so forth. Digital information is not inevitably exposed, but one cannot guess a priori the contexts in which it will surface. The safest assumption is “this could show up on the evening news.”

Toda explores the means by which we establish and maintain status and social relations. Status is a major concern in human and other primate societies. A contemporary egalitarian ethos may cause us to operate in this sphere more subtly and with less conscious attention, but it remains supremely important. Toda analyzes the role of informal conversation (such as chatting and gossip) in social positioning. A key characteristic of such discourse is that is ephemeral, recorded only in imperfect memory.

In [2] I explore Toda’s observations in the context of email and instant messaging. Email was welcomed as an informal, conversation-like alternative to written correspondence. At the time, disks offered limited storage capacity and printing was expensive. Later, saving email became routine and email became more formal. More recently, instant messaging was welcomed as an informal, conversation-like alternative to email. In both cases, an ephemeral medium supported the casualness, imprecision, posturing, blustering, provoking, and bantering that is part of social network maintenance but which can have a negative effect when viewed out of context. However, features are being added to enable message sessions to be saved so that we can review them. Can we manage without the ephemeral communication that has served us for millennia? Ubiquity and perceived efficiency work against ephemerality.

Consider once again a meeting, recorded and archived for later viewing. Someone is late; those waiting, mildly frustrated, joke at his or her expense. Seen by those present as good-natured defusing of frustration, it may appear less tasteful to a later viewer who was not there; the late arrival checking to see what was missed, perhaps. In the meeting, a caustic critique is delivered, the speaker not anticipating who will later view it, similar to email composed without considering how it will look when subpoenaed by a competitor’s attorney. One person’s sense of humor leads to a risqué remark that another quickly deflects—“let’s not go there” —harmless banter perhaps until taken from context to create an impression of a hostile work environment. And of course an ‘expiration date’ for a file is no more reliable than “please delete after reading” added to an email message.
Context is critical to interpreting social behaviors, context that is stripped away by digital mediation. Systems that do not mesh with natural social behavior will fail or lead to unforeseen outcomes. Frustration that cannot be defused harmlessly may find other outlets. If meetings can be viewed by posterity, will we avoid them and seek other places for ephemeral expression? And if we leave no such refuge, if computing becomes truly ubiquitous, what will our ancestors say to us?


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