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Collaborations in Ubiquitous Workspaces: Literacy for Workplace Ecosystems

Toshihiko Yamakami†

The drastic network changes emerged in the every day computing environment. The mobile Internet and ubiquitous computing environments penetrate into the daily life and workplaces. The author describes the challenges and describes the impact from the issues in the five domains: technosocial situations, multiple ecologies, boundary, privacy and norm development. Then, the author presents the new set of social skills in the ubiquitous empowered workplaces. These challenges are fundamental in the ubiquitous computing environment, which the human beings have to cope with. The author describes the social and cognitive design using the literacy and ecosystem frameworks.

1. Introduction

We are witnessing two new emerging trends in the every-day network environment. First, we are empowered with the mobile Internet. It expands its data transmission speed and enhances its real world integration. Second, the diverse appliances at hand start to be Internet-enabled. The digital appliances and home networks emerge with implementations and standardizations. These two trends create the digital gateway on the palm with the enhanced public and local access. The ongoing network advances significantly impact the workplaces and knowledge management. It will create the opportunities and challenges. In this paper, the author attempts to identify the new challenges from the emerging network-enabled every-day workplaces, referred as *ubiquitous computing environment.* The author presents the implications from the past computer-supported cooperative studies in technosocial situations, multiple ecologies, boundaries, privacy and norm development. Then, the author proposes new concepts of workplace literacy and knowledge eco-system to cope with the challenges.

2. Challenges in the ubiquitous workplaces

A ubiquitous computing environment is leveraged with the advances of wireless communications and identification systems like RFID. It facilitates the object tracking and enhances intelligent support in the workplaces. This is a significant forward step to release from the existing environment. Now, the objects in the environment have capabilities to behave in an intelligent manner without human intervention. However, the social impacts from this emerging setup are rarely studied. So-called *any time, any place communications* release the restrictions of the creative activities. When Weiser[1] proposed the concept of ubiquitous computing, it came from the reconsideration that the task itself, not the computer, is the target for human beings. The ubiquitous computing proposed by Weiser provides the invisible interface to make the task-centered context with less visibility of the computers. We have an opportunity to revisit the word *ubiquitous* with the wide range of implementation technologies. The leveraging technologies force us to revisit the social aspects of the empowered workplaces.

The author categorizes the challenges in the following five categories:

- technosocial situation problems,
- multiple ecologies problems,
- boundary problems
- privacy problems, and
- norm development problems.

First, the wireless telephony and the wireless Internet expose the technosocial situations. Like a phone talk in a crowded train, the new emerging technology arises a new conflict in the social places. The communication use of the emerging technologies easily brings more social conflicts as well as the benefits.

Second, the ubiquitous environment creates multiple ecology systems. Interface ecology is

† ACCESS, 2-8-16 Sarugaku-cho, Chiyoda-ku, Tokyo, JAPAN, e-mail:yam@access.co.jp

a relatively new concept. It was coined by Andruid Kerne in 1997[3]. It is a concept to investigates the dynamic interactions of media, cultures, and disciplines that flow through interfaces. Kuzuoka et al[4] proposed a new concept of dual ecologies to focus on the duality of the remote/local robot communication media. Each segment of workplace can have multiple coverage of the workplace layers. When different layers of the workplace coexist, it creates multiple ecologies for the people at the segment. When the systems are empowered with the wireless communications, there is no knowledge how many layers overlap on the segment. Therefore, this poses both of a) implementation and deployment problems, and b) social and cognitive problems.

Third, the boundary problems are serious in the ubiquitous workplaces. When the boundary is bound to the work contexts, this also leads to another set of multiple ecologies problem. There are many boundaries in workplaces like task boundaries, organization boundaries, and context boundaries. The fits between the technology boundaries and social boundaries are the challenges.

Fourth, the privacy is a critical social problem. The privacy issues were intensively discussed in[2]. The author does not cover the fifth issue in this paper. Not just for privacy protection, the global public unique names are under threat under mobile unsolicited bulk email (MUBE). In the Japanese mobile Internet, the average length of the mobile email continues to grow during last 5 years to protect against MUBE.

3. Implications from the past research

3.1 Technosocial Situation Problems

Ito[5] showed the emergent new norms in coexistence and city space experience using wireless communications. She proposes the concept of *technosocial situations*. The technosocial situations are different from the physical situations. For example, when a person starts to talk on a mobile handset, it does not change any physical environment. The new context is driven by the social acts, in this case, a verbal discourse. However, this completely changes the social context without any new physical changes. It is an interesting question why people feel uncomfortable when another starts to talk on a mobile phone. The surrounding persons are drawn into new context without their intentions. The discourse naturally invokes the new inner attitude to respond to it. They know that the context is irrelevant to them, therefore they try to suppress the invoked inner attitudes. This inner effort leads to no new outcome. In addition, the discourse is half hidden over the mobile phones. This fragmented situation and the meaningless of their inner efforts make the people uncomfortable. This is a common scene in the Japanese society. In the ubiquitous environment, we can use some analogy from this fragmented mobile communication case. A user may feel uncomfortable when they suspect there are some implicit intentions embedded in the environment. In order to ease users, a system can provide a flash or a beep to make their transactions sensible for users, which may cause another trigger of the technosocial situations.

Accessible to the public gateway
Accessible to the local gateway
Accessible to the unidentifiable entities
Accessible to the identifiable entities

Fig. 1 Four Levels of Technosocial Distances in the Ubiquitous Computing

3.2 Multiple Ecologies Problems

Kuzuoka argued that ecology is a sustained challenge in CSCW. Graver discussed this topic in relation to the affordance, and Heath et al discussed it in relation to communicative asymmetry, Luff et all described it as *fractured ecologies*. Kuzuoka coined a term *dual ecologies* when they argued about the unintentional project-ability caused by body orientation and movement. There are many occasions that the mismatch in the ecologies gives a false anticipatory reactions. Kuzuoka described that the unintentional actions lead to the inconsistent anticipations. In the ubiquitous environment, highly advanced helps from the environment also causes this type of multiple ecologies. In the ubiquitous environment, users may encounter multiple inconsistent ecologies in the simultaneous multiple context-switching environment. The invisible wireless contact structures create a new four-layer model of technosocial distances embedded in the ubiquitous environment outlined in Fig. 1. Hall[6] identified

four bodily distances–intimate (0 to 18 inches), personal-casual (1.5 to 4 feet), social-consultive (4 to 10 feet), and public (10 feet and beyond)– as key points in human spacing behavior. It was a frontier-opening result for personal space research. The technosocial situations in the ubiquitous computing environment create similar four-layer structure in the cognitive space for the workers in the workplace. Social distances have two interesting aspects: a) discreteness in the four social domains, and b) ambivalence in the third party person invasion into the inappropriate space. The similar situations may occur in these technocsocial distances, however, the in-depth research is for further studies.

3.3 Boundary Problems

3.3.1 Multi-dimensional Simultaneous Social Contexts

The mobile Internet solved the last 1-mile problem of the telecommunications. It is not intruding like other methods like voice communications. The average duration of the mobile Internet access is several minutes: a click-and-away behavior. This behavior invokes the multiple context co-existence with the always-on always-clickable nature. The unit time for human activities become fine-grained and fragmented. People decide on their TV video clips in seconds, and children play the piano in the piano school with a faster tempo. The continuity of the workplace relations need enhancement in this situation. The excess use of switches could impact social relations rather than providing the context choice freedom for end users. Harrison et al discussed the limitations in the space model and described the separate treatment of space and time in the collaborative works[9]. However, the further advances in the wireless technologies make such distinction more difficult. The creative social activities need the credit recognition. The credit should be given to the original contributors in the creative activities. The implicit discontinuity in the technology-augmented works makes this social act more vague. The legacy real-world environment provides the physical restrictions and physical cues for knowledge. The discontinuity often provided by the real-world environment facilitates the we-ness, focus-on-neighbor-knowledge, and intra-social-relationship. This type of unintentional use of the discontinuity in the environment may be missing. When people started to use the mobile phone, they started to ask *what are you doing?* when they opened the communication. This implies the social context conflict with the any-time any-place communications.

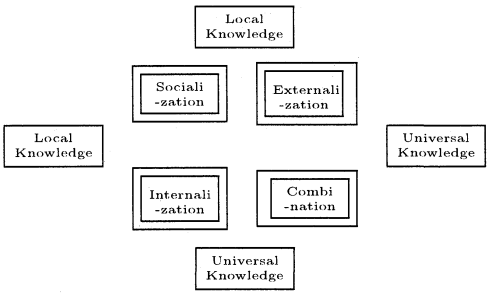

Fig. 2 A SECI Model variation with focus on Knowledge Locality

3.3.2 A new view on the SECI model

The boundary issues in local/global context also impacts the knowledge management. The SECI model is well known in knowledge science in order to describe the spiral development between implicit knowledge and explicit knowledge[7]. It is known in the organizational breakdown analysis that the 30 % of the office knowledge depends on the location[8]. Locality in knowledge facilitates the efficient communication with the neighbor members using the local context. A locality-focused variation of the SECI model is depicted in **Fig. 2**. This locality-focused view fits the ubiquitous workspaces because locality of the knowledge is generally easier to handle than the tacit-ness of the knowledge. When the boundaries of local/global knowledge become vague, it may pose another cognitive burden on the users. It needs further large-scale research to uncover this issue.

The location is well equipped with intelligence, and provides the local support for the embedded intelligence. This embedded intelligence may facilitate the knowledge process. However, this local ambient knowledge may be stored without refinement. This will reverse the implicit assumption that knowledge is refined when stored. The overloaded local pile of information collected by the embedded intelligence may include further security and privacy information. When some daemon agent filters the information, we have to verify how and why

the information filtering done by the daemon agent.

3.3.3 Boundary Awareness

At the boundary, there could be many things happening:

- Filtering,
- Alerting,
- Converting,
- Context switching.

In the ubiquitous computing environment, the matching between physical boundaries and social boundaries become obscure. When information transfer needed conscious effort, it naturally brought the boundary awareness. Orlikowski et al focused on the concept of technology-use mediation. They suggested that the implementation and use of technologies can be facilitated by the explicit and ongoing adaptation of the technologies to the organizational context and vice verse. The technology-use mediation support in the ubiquitous environment is challenging because many of the features are potentially invisible to the members. The Orlikowski et al coined the term *metastructuring*. How the metastructuring is applied in the transparent ubiquitous environment is still to be explored. The boundary overlap may include several different patterns:

- Social Boundary > Physical Boundary,
- Physical Boundary > Social Boundary,
- Overlapped boundaries.

The design methodology how to cope with these patterns is for further studies.

3.4 Privacy

The machine-administrated environment creates a privacy threat like monitoring and recording. The rapid mobile Internet penetration into the every day life shows a wide range of anomalies in the today's society. Examples include:

- interactions with too many mobile mail mates (more than multiple hundreds without any real world encounters),
- people addicted to the small gadgets who feel extensive anxiety without holding mobile handsets),
- multiple masquerading acts in the mobile Internet, and
- people feeling intimate and private consultation dialogues with completely anonymous persons

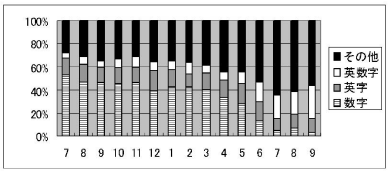

Fig. 3 Character category choice patterns in mobile e-mail addresses(2001)

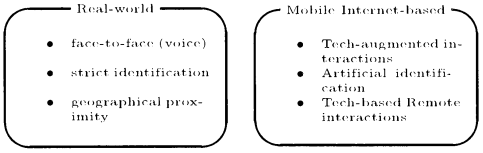

Fig. 4 Comparison between real-world interactions and mobile Internet-based one

Identity is the fundamental base for the social relation. The mobile e-mail address character pattern transition example in 2001 is shown in **Fig. 3**. The identity space in this example differs from the ordinary nickname or real name based PC free names. On the mobile e-mail addresses, the length of the e-mail addresses continue to increase due to the mobile bulk commercial e-mail attacks. This is a unique phenomenon in the mobile Internet.

3.5 Norm development

The anyplace social interactions without any physical bindings lead to the wide range of new social behaviors without establishing the real norms in the mobile Internet. A comparison with the mobile Internet-based interactions and typical real-world interactions is shown in **Fig. 4**.

The mobile technology-augmented mind is supported by the 24-hour always-on technologies. This emulates the real-world interactions and replaces them. The author provides an AIMS model to describe the always-on technology based norm development in the mobile technology-augmented society. This model explains 4-staged formation of the social mind from four components: availability, responsibility, social memory formation, and social norm development. The social mind formation model is depicted in **Fig. 5**.

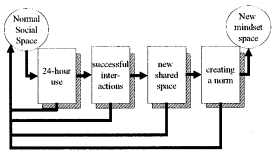

Fig. 5 An AIMS Model

Basic Communication Skill	Media Communication Skill	Computer Communication Skill	Simultaneous Multi-dimensional workplace Skill

Read/ Write	Media Cognitive Skill	Computer Network Cognitive Skill	Ubiquitous Cognitive Skill

Fig. 6 Environment evolution and human skills to cope with it

4. New Workplace Literacy

4.1 Workplace Literacy Development Framework

The author proposes a concept called *new literacy for ubiquitous workplace*. The challenges described in the previous section have no ultimate solutions because they are inherited in the fundamental subtle characteristics embedded in the human society. The list comes from the decades-long computer supportive cooperative research to aim at the resolution between technologies and human beings with emphasis on the human side.

The magnitude of the evolution and the tight relationship to the real world drives the new skill demands for end users. The end users need to learn the functional model of the ubiquitous environment, the cognitive modeling of the conflicts in the ubiquitous environment and the possible social interactions in the ubiquitous computing environment. The users need to capture the functions of each computing component, and the arbitration mechanisms among them. Other cognitive and social skills follow. The users need to master how to code the user demands in each ubiquitous environment. This leads to the new type of literacy, which the author calls *ubiquitous environment literacy*[10]. The evolution to this new type literacy from the legacy literacy sets is shown in **Fig. 6**. The users need to adjust to the new ecosystem including access systems, recording systems, trace systems and distribution systems. The middle 20th century invention of the mass media and the late 20th century invention of the computer communications lead to the new types of literacy, media literacy and computer literacy, respectively. The invisible interface in the ubiquitous environment further increases the need to fill the gap between the environment implementations and the user of it by human beings. Especially, the human beings' capabilities are limited when the multiple simultaneous environments co-exist and interact.

There are three types of supports in the multi-dimensional simultaneous environment:

- Location-based SECI process support,
- Filtering support and filtering awareness support, and
- Context continuity support against floating and dynamic contexts.

We have to revisit the basic nature of the collaborative knowledge evolution and give a guidance for the new type of literacy: *ubiquitous computing literacy*. The devices used in the ubiquitous computing are diverse and include a different set of constraints. Most of the diversity may be hidden behind the scene. The ubiquitous workplace literacy needs the following support:

- acknowledging boundaries, contexts, switching, and their dynamic changes,
- sharing the cognitive evolution and norm under development, and
- clarifying technology consequences and social consequences.

These functions are difficult to implement in the later stage, therefore, it needs design consideration in the early stages.

4.2 A Knowledge Eco-system Concept

In order to build the comprehensive workspace literacy in the knowledge management in the ubiquitous workplaces, it is important to consider *knowledge ecosystem*. Knowledge ecosystem is a sustainable environment to retain the factor to drive the evolution of knowledge in an organization. Knowledge ecosystems include the following factors:

- knowledge refinement,
- effort rewards including credit respect,
- human relation evolution,

- sustained knowledge development.

There are some assumptions in the healthy knowledge eco-systems:

- Monotonic increase of quality knowledge,
- Knowledge is in the easy treatable range,
- Knowledge creation process gives positive feedbacks to the interpersonal relations,
- Knowledge creation efforts are rewarding, and
- Knowledge gives positive effects to the members.

The ubiquitous workplaces and their literacy support systems need features to support knowledge eco-systems. Without the positive commitment for the knowledge eco-systems, it hardly achieves the healthy knowledge development. The author thinks that the dynamic nature of the knowledge eco-systems cannot be achieved in the system-only design. The complementary support from the literacy support systems will facilitate the long-term complicated social behaviors like knowledge development in the ubiquitous workplaces. It is important to adjust the wrong user feelings like machine-dominated knowledge workplace, easily introduced in the ubiquitous environment.

5. Conclusion

The advances in home networks and information appliances network drastically changes the every day network environment. The ubiquity of the computing may impact the social lives in a large-scale and permanent manner. The human beings are not programmed to capture such complexity[2]. The technology-augmented society empowered by the advanced wireless networking may enlarge the gaps between human beings and technology-augmented workplaces. The author describes the potential workplace issues in five domains: technosocial situations, boundary management, multiple ecologies, privacy, and norm development. The multiple simultaneous contexts and invisible supports behind the ubiquitous computing may impact the fundamental parts of the social interactions. The social skills to cope with this impacts are discussed from a viewpoint of the ubiquitous computing literacy. It is ironical that the ubiquitous computing originally designed in order to remove the gaps between the human beings and the target tasks create the new conflicts surrounding the human cognitive world. In order to properly augment the human capability in the high level social interactions, it needs to cope with this newly emerged challenges. This paper formulates the new framework to understand the potential social issues in ubiquitous computing-empowered workplaces. The author proposes new concepts: ubiquitous workplace literacy and knowledge eco-system. The author emphasizes that the social and cognitive skill support for the total workplace eco-system is as important as the individual implementation and deployment. The discussions described in the paper need further quantitative evolution to lead to the rigid foundations for the ubiquitous workplaces. The measures to compare workplace literacy and knowledge eco-system fitness are for further studies.

References

1) M. Weiser, "Some computer science issues in ubiquitous computing," *CACM*, vol. 36, no. 7, pp. 75–84, July 1993.
2) J. Grudin, "Issues and challenges in ubiquitous computing: Group dynamics and ubiquitous computing," *CACM*, vol. 45, no. 12, pp. 74–78, December 2002.
3) A. Kerne, "Interface ecology," *Interactions*, vol. 5, no. 1, pp. 64, Jan/Feb 1998.
4) H. et al Kuzuoka, "Dual ecologies of robot as communication media: thoughts on coordinating orientations and projectability," in *CHI'04*. April 2004, pp. 183–190, ACM.
5) Mizuko Ito and D. Okabe, "Technosocial situations: Emergent structurings of mobile email use," available at http://www.itofisher.com/PEOPLE/mito/mobileemail.pdf, 2003.
6) E.T. Hall, *The Hidden Dimension*, Doubleday & Company, Inc., New York, 1966.
7) I. Nonaka and H. Takeuchi, *The Knowledge Creating Company*, Oxford Universtiy Press, 1995.
8) 山上俊彦, "Virtual workplace literacy: 閣俳と課題," in *DiCoMo* ワークショップ. July 1997, pp. 377–382, 情報処理学会.
9) S. Harrison and P. Dourish, "Re-place-ing space: the roles of place and space in collaborative systems," in *ACM CSCW'96*, November 1996, pp. 67–76.
10) T. Yamakami, "Ubiquitous computing literacy: a new challenge for social computing," in *Proceedings of EUC2004*. August 2004, vol. LNCS 3207 of *Lecture Notes in Computer Science*, pp. 712–723, Springer Verlag.