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An embedded intelligence model: Issues in the real-world empowered organizational computing

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Ubiquitous computing will penetrate into the cooperate workplaces. Additions of machine-machine interfaces in the organizational computing pose new framework challenges as well as implementation and deployment issues. The author discussed issues in *hybrid organizational computing* to cope with the pervasive and ubiquitous intelligence in the workplaces in the previous work to follow the proposed *ubiquitous workplace* concept. The author discusses various dualities exposed in the ubiquitous workplace like a) space vs. place and b) logical organization and real world. The ubiquitous workplace will pose more challenges for the organizational computing from the dualities. For the resolution of these issues, the author proposes and discusses *an embedded intelligence model* for organizational computing.

1. Introduction

The word *ubiquitous computing* is nothing foreign to the people these days. The advances of ubiquitous computing technologies involve rendering them as an inseparable part of business as well as our every day life. The RFID (radio frequency identification) and other techniques enables the intelligence embedded in the real world. Grudin mentioned "The vision of ubiquitous computing has centered on potential benefits of widely distributed input and output devices-sensors, effectors, and displays that will be carried, worn, or embedded in the environment."[1)] This brings a wide variety of the new opportunities for the organizational applications like work-flow systems, security systems and knowledge-sharing systems and collaboration support systems. We are witnessing two new emerging trends in the every-day network environment. First, we are empowered with the mobile Internet, which evolves at a drastic speed. It expands its data transmission speed with increased capabilities. It enhances its real world integration. Real world integration is enabled by emerging new technologies including networks, hardware and software. Second, the diverse appliances in the everyday life 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. From these trends, the author proposed a concept of *ubiquitous workplace environment* and *hybrid organizational computing* in the past research. The author presentsed the implications from the past computer-supported cooperative studies in technosocial situations, multiple ecologies, boundaries, privacy and norm development. The ubiquitous workplace environment is a workplace empowered by ubiquitous computing. The emerging power of ubiquitous computing will expose the complicated dualities of the organizational computing. In order to resolve the exposed complexity, the author discussed hybrid organizational computing to enable mapping between the logical organizational computing and real-world computing. In this paper, the author further extends this argument to lead to *embedded intelligence*, which will help the everyday collaboration using ubiquitous computing. From the author point of view, the challenges in the organizational computing is how to deal with the complicated nature of organizational computing further accelerated by ubiquitous computing power. The organizational process is complicated, open, and dynamic. The ubiquitous computing will solve some of the problems and expose new problems in workplaces. The author summarizes the previous discussions on the ubiquitous workplace environment and discusses an embedded intelligence model to deal with the ubiquitous work-

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place issues in a consistent manner.

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[2] 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.

Ubiquitous workplace is a workplace that is empowered with ubiquitous computing[3]. The ubiquity in a workplace brings a wide range of cognitive/social challenges in the organizational computing[4]. First, the non-human responses generated in the embedded computing entities will create a technosocial situation. The wireless telephony and the wireless Internet expose the technosocial situations. Ito et al coined this concept[5]. Ito showed the emergent new norms in co-existence and city space experience using wireless communications. She proposes the concept of technosocial situations. Like a phone talk in a crowded train, the new emerging technology arises a new conflict in the social places. 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. The communication use of the emerging technologies easily brings more social conflicts as well as the benefits. The technosocial situations are different from the physical situations. 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. Talking in a crowded train leads to unnecessary suppressing of the discourse-based reactions, which causes uncomfortable feeling. Second, the ubiquitous environment creates multiple ecology systems. Interface ecology is a relatively new concept. It was coined by Kerne in 1997[6] . It is a concept to investigates the dynamic interactions of media, cultures, and disciplines that flow through interfaces. Kuzuoka et al[7] 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 coverage of the multiple 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. In the ubiquitous environment, users may encounter multiple inconsistent ecologies in the simultaneous multiple context-switching environment. 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. Harrison et al discussed the limitations in the space model and described the separate treatment of space and time in the collaborative works[8]. 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 discontinu-

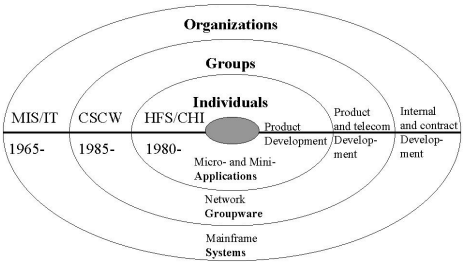

Fig. 1 Grudin's view on CSCW development

ity 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. Fourth, the privacy is a critical social problem. The privacy issues were intensively discussed in[1]. The invisible boundaries embedded by the ubiquitous workplace infrastructure will lead more complicated privacy management. These issues are loosely related to the issue how the new real world integration dimension is integrated in the organizational computing framework.

Many issues in organizational computing are social and cognitive. It needs further soft-landing support mechanism like ubiquitous literacy[9].

3. A Hybrid Workplace Computing Model

The office system development is outlined in **Fig. 1**. It started from MIS, then workstation and PC systems, and finally reaches Computer-supported cooperation systems. It is to be noted that the extension of the computing power gradually covers the logical artifacts of the business community.

In the past, this framework logically encapsulates the details of the physical environment. At the MIS age, the details of the physical workplace were irrelevant to the management information analysis. At the HFS/CHI stage, the human interface was extensively studies, however, it is for the providing interfaces to logical systems, not the physical systems. The physical

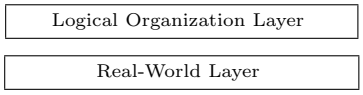

Fig. 2 A Two-Layer Model of Real World Organizational Computing

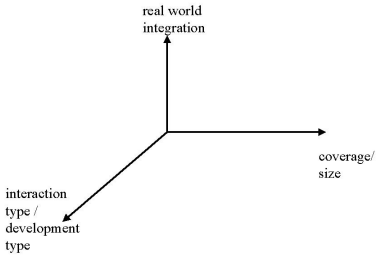

Fig. 3 A Three-dimensions Model

systems were abstracted for computing. In the CSCW stage, the media integration was studied mainly for interaction enhancement. Even with the final stage, the end users need to be cast into the artifact-world in order to align to the logical world. The two layers in the workplace is depicted in **Fig. 2**. It shows that the workplace consists of two layers, a logical layer and a physical layer. It is beyond just dynamic hypermedia using real time interactions[10]. The physical layer was intentionally encapsulated in the traditional organizational computing. It makes the embedded intelligence virtually out of scope because there is no interface for logically hidden components.

The ubiquitous workplace needs the third horizontal dimension to the 2-dimensional view on the Grudin's evolution map. It is outlined in **Fig. 3**.

The author coined the term hybrid organizational computing. The computer processing needs identification and naming. When such a process-able granularity is not guaranteed, the organizational task was performed out of scope of the organizational computing. Only the result of the task was captured in the computing model if possible. The author calls it logical organizational computing. The physical details of the task were hidden behind the computing scene. The author classifies it physical organizational computing for the discussion. This was not captured as computing in the traditional model. The hybrid organizational computing fills the gap between the logical organizational

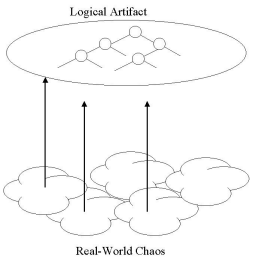

Fig. 4 A one-way real-world Model

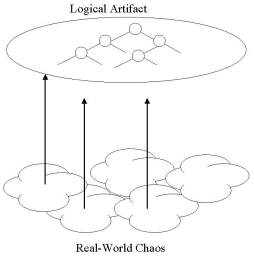

Fig. 5 A two-way real-world Model

computing and now exposed physical organizational computing. Using the GPS or other positioning systems and RFID or other identification systems, the real world is not an unidentifiable chaos. Some part of it could be more systemized than the traditional logical organizational computing. Real world integration leads to the new perspective to identify local/global task/interaction.

When the real world integration opens up the opportunity to embed intelligence directly into the physical workplace, the embedding scheme needs to be explored. The logical artifact based approach is outlined in **Fig. 4**.

Another approach, real world driven one is outlined in **Fig. 5**. This is a completely new perspective that is driven by the real world integration-focused approach. The diagram illustrates the structured knowledge structure exists inside the physical layer. Only recent development of ample computing entities embedded in the workplace interconnected by the wireless communications enable this approach.

The real world integration exposes logical entities embedded in the physical environment. It also impacts the organizational boundary issues using real world interfaces embedded in the workplace. It should be noted that the model described in Fig. 5 is not a single flat layer model. The real world is not flat from the organizational point of view. The relations

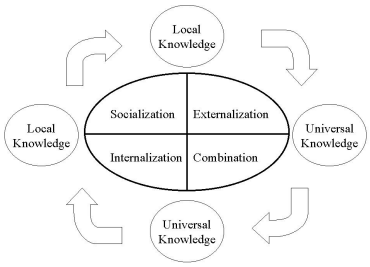

Fig. 6 A global/local based CETI Model

among the real world components are defined in work contexts. In a laboratory environment, we can assume that there is single hierarchy in the physical layer, however, it is just one of the abstractions of the real world. The author describes an example where the new exposure of the physical layer directly impacts the organizational knowledge process. It is a SECI model using local/global dimensions. 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[11]. It is known in the organizational breakdown analysis that the 30 % of the office knowledge depends on the location[12]. 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. 6**. 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. This is a reflection of the exposing the physical entities in the organizational model.

4. An Embedded Intelligence Model

The organization has multi-faceted boundaries in tasks and communities. 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

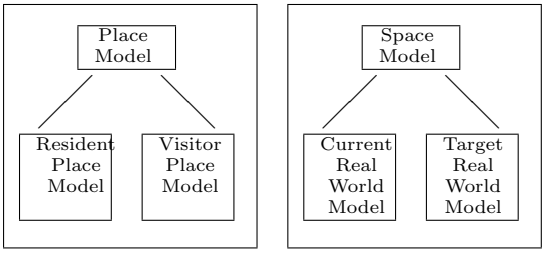

Fig. 7 An Embedded Intelligence Model to support Ubiquitous Workplaces

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. The ubiquity of computing brings a new challenge for the organizational computing. Frankly speaking, the any-time any-place connectivity will expose the variety of dualities embedded in the organizational computing. The author proposes an embedded intelligence model In order to resolve the following dualities:

- Place vs. Space,
- Current Real world vs Target Real World, and
- Visitor view vs Resident view.

The proposed model is depicted in **Fig. 7**, which reflects the embeded dualities in the organizational computing. The author adds the visitor view and the resident view in this model in order to support embedded intelligence based just-in-time learning applications. The learning in the real world will facilitate efficient learning with the on-demand learning with real world interactions. However, the past research lacks the resolution of visitor/resident conflicts. Also, the author thinks the support for the knowledge authoring support is important. When there is insufficient authoring support, the real world learning will be biased by random build-up and the lack of consistency will significantly impede the efficiency of the real world learning.

The proposed model focuses on the authoring support as well as the execution model. The challenge for authoring is leveraged by the flexibility of the 3-D real world applications.

5. Discussions in the hybrid organizational knowledge modeling

The discussion in the hybrid organizational computing implies several new research directions. First, the framework research on modeling 3-dimentional workplaces with real world integration is needed. It will open the research issues like ubiquitous workplace knowledge structure. In the past, the knowledge structure just reflects the logical components in the workplace. The binding to the physical locations and the interrelations among physical locations need context-fit modeling. The organizational knowledge authoring tools to support hybrid organizational computing need in-depth studies. It provides the bases for embedded intelligence, just-in-time learning, and embedded guidance. It is a new challenge for organizational knowledge capturing. Hybrid organizational computing needs hybrid knowledge model. There are two approached to construct hybrid knowledge model. One approach is to add the real world integration interfaces to the traditional organizational knowledge model. The other is to construct the real world knowledge and embed the existing organizational knowledge into it. Second, the legacy logical structure encapsulated the dynamism in the physical environment. The new hybrid model exposes the dynamism in the underlying workplace contexts. It will give another challenge in addition to the task dynamism, interaction dynamism and organizational structure dynamism. Third, the cognitive and social challenges like technosocial situations and multiple ecologies need additional features on the hybrid organizational knowledge. These issues need long-term field studies. It is for further studies. Fourth, the hybrid organizational workplace may lead to the new organizational norm development. It is an interesting topic, however, the total environmental evolution of organizational computing is far beyond the current research effort at the moment. The context-specific research may contribute to identify the issues in well-defined terms.

6. Conclusion

The advances of ubiquitous computing will inevitably lead to the ubiquitous workplace

where the workplace is empowered by the ubiquitous computing. The advances in the global wideband wireless networks, neighborhood wireless networks, RFID, and other smart media technologies aggressively lead us to this new world. The computers have become fast, cheap and compact. The computers have moved out into the every day world. They will have become a key part of the fabric of human communication and pervade the rhythms of our everyday work. The ubiquitous workplace is a fancy new opportunity of organizational applications. At the same time, it will bring new challenges for cognitive aspects of the organizational computing. The organizations inherit various boundaries and encapsulate multiple mismatches in the physical environments. The illusion of the seamless ness will lead to the more confusions and embarrassment in the organizational contexts. In order to resolve the issues in hidden parts of the organization, a hybrid organizational model is needed to absorb the emerging ubiquitous computing in a workplace. In this paper, the author describes an embedded intelligence model to resolve the conflicts like a) space vs. place, and b) logical organization and real world reality. This model extends a hybrid organizational model with the place and space separation. It brings attention to awareness of the pervasive computing element embedded in the workplace. It is still to be explored how the real world integration will impact the organizational computing. Many issues in organizational computing is social and cognitive. It needs further soft-landing support mechanism like ubiquitous literacy. Enhancing the current workplace needs fundamental impacts on the user's mind and way of thinking in a workplace. The propose model combines the duality of a) place and space, b) visitor and resident, and c) as-is real world and target real world. Embedded intelligence is an emerging application field that will help workplace productivity with real-world computing technologies. As well as the technology development, it is important to coin a consistent framework to develop embedded intelligence because it is more difficult to construct a knowledge structure with 3-dimensional real world than the current organizational environment. In order to practically enhance embedded intelligence, it is critical to build insightful support to detect the knowledge gaps and holes in the real world setup. The proposed model is a first step to construct such support environment to realized real world integration applications with systematic knowledge construction.

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