Space prototypes for achieving "Ubiquitous Computing":

Reconfiguring the existing space with physical interactions

Jia-Yih Joy Chen

Department of Architecture, Nan Ya Institute of Technology, Taiwan
jiayihchen@pagic.net

Abstract. In this project, "Ubiquitous Computing" space prototypes with new embedment of context information are studied. Through the related theories, research models and experiments, the prototypes for future information space and user styles are proposed, including space modules, user behaviors with physical HCI interactions, and required information technology. Space prototypes for exhibition and lab areas with supported infrastructure and interface are tested in the experiments.

Keywords. Ubiquitous Computing, Interactive Space, Information Space Design

"Ubiquitous Computing" space and related works

The global thoughts of "Ubiquitous Computing" (Weiser, 1991) are now prevailing everywhere in the field of Information Technology. The representation of digital information in the form of "Embodied Virtuality" makes physical building space or structures become conveyors of information. "Context-Awareness Computing" (Dey and Abowd, 2001)(Moran and Dourish, 2001) between user and space arouse new ideas for space designers to explore different possibilities through the support of information technology. Impacts from the integration between information technology and physical space design are the innovative issues for architects to explore.

For dedicating the trend of collaborating works, reserved surfaces for large display with wireless LAN environment supporting portable devices become a new standard for a interactive conference space. (iRoom: Johnson, Fox and Winograd, 2002) The versatile forms of design media including paper, physical model, and digital data representation need a platform to reduce the cognition load. (Jeng and Lee, 2003) Wide ranges of HCI (human-computer interaction) applications limited in the desktop computer will weave into our everyday life and transformed to human-information interaction and human-human communication and interaction. The dimensions and perspectives of work space are important design issues for integrating real and virtual worlds (Cooperative Building and iLand: Streitz, et. al., 2001) and the key elements for a Context-Aware Intelligent Environment (CAIE) (Shafer et al., 2001) are important references for this research to setup the criteria for interactive space design.

Research Background

In Taiwan, the directions of "Information Architecture" for achieving spaces with "Ubiquitous Computing" and "Context Awareness" by tangible user interface tools were explored in the research of IA Lab in National Cheng-Kung University. (http://www.arch.ncku.edu.tw/ ialab) Through the previous research and interaction experiments on applications of architectural design

review and critique, different modals and devices of interaction were tested. The ongoing long-term project for the integration of the previous works called "iCube"(Jeng and Lee, 2003) provides multi-modal multi-devices ubiquitous computing environment. Based on the human-centered interaction model for physical and virtual representation (Jeng, et. al., 2002), further step is to achieve an information mapping model for integrating physical and virtual space. The IA lab space is now undergoing a space reconfiguration for demonstrating the above ideas. Since the previous efforts are contributed to bottom-up knowledge for lab space, in this paper, a top-down view to seek a prototype as guidelines for future information space designers to refer.

Prototype study for reconfiguring the space of IA Lab

"Prototypes are conceptional schemata for the representation of generalized design knowledge. Design with prototypes implies generating a variation of the design…. It is possible to work with prototypes at different levels of abstraction." (Schmitt, 2000). For adapting the new design issues aroused from new emerging technology as the related thoughts and works mentioned above, reconfigurations for existing spaces will become frequent in the near future. Thus, prototypes for different functions of space to fulfill the purpose of smart space with the concept of ubiquitous computing and human-centric design will become a new discipline in the building design field.

In this study, named space or room title, identified by the level of construction or building structure, will be split into more sub-areas according to its space context especially by level of function and user interactive behaviors. Interactive models will be discussed by the unit of sub-area, then find out the relations or linkage between sub-areas. To follow the previous thoughts, the task analysis of the lab space context including location, identity, status and time (Dey, 2000) were summarized as shown in Table 1. The physical layout for the lab floor plan before and after reconfiguration is shown in fig.1. The lab space is split into 3 sub-areas, i.e. conference area, working area and data area in terms of function level which reflects the information flow pattern in lab, i.e. input-processing-output. There are two overlapped parts of the sub-areas as shown in the Fig.1 . For clearly defined the level of interaction, then further split the lab space into 6 physical interactive zones, i.e. zone 1. for "entrance, display & security ", zone 2. for "Experiment & demo", zone 3. for "Preparation & production", zone 4. for "individual work & group discussion", zone 5. for "Professor's counseling area ", zone 6. for "Data retrieving & device storage". According to these tasks, we propose the context control modes and will link to database server for facility management, schedule setup, data-retrieving, information display, etc.. In each zone, each task proposed could be completed by several devices coordinated together or one element, such as door, composed of several tasks, e.g. entrance, display and security.

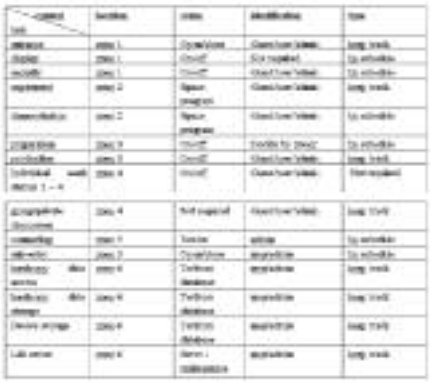

Table 1.task analysis of space context in the lab

Figure 1. the lab space layout before and after the reconfiguration

Figure 2. photos of the conference area befor and after the reconfiguration

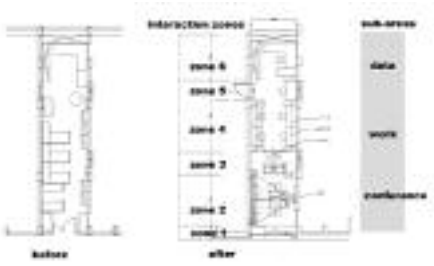

Figure 3. designer's knowledge domain and workflow for designing an ubiquitous computing space.

Discussion

The Fig. 3 below reflects issues from new knowledge domains need to be considered in the designer's workflow for designing an ubiquitous computing space. In this study, the lab space reconfiguration is still ongoing. For further study, we will keep working on matching the setting of space context with the information infrastructure. Except for the physical configuration reached in this study, information infrastructure and user interaction behaviors levels of study and usability testing will be proceed in detail.

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