An Intelligent Workspace

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The Problem: To build workspaces that effectively support people in everyday work situations, one needs to focus on both the technology and the physical environment in which work takes place. Much progress has been made in recent years in developing technology: Research in intelligent spaces—those spaces in which technology has been embedded in support of people's tasks—has focused on such issues as computing resource allocation, multi-modal interfaces, new sensor development, and applications that support workplace tasks. Progress also has been made in the design of physical spaces that support the wide variety of tasks that take place in office environments. Much of this work has focused on what people do in office environments and how the types and arrangements of physical elements—windows, walls, furniture—influence everyday tasks. It is now time to merge the two efforts.

Motivation: Intelligent spaces are an integral part of what is often called ubiquitous, or pervasive, computing—making useful technology virtually invisible in our lives. Researchers are still in the early stages of this field, and do not yet have answers to questions of how to make computing accessible anywhere that we need it, adaptable to changes, and not only useful, but enriching in our daily lives. We can make progress toward answering these questions by creating environments that help to make our everyday tasks both simpler and more enjoyable. In the workplace, such environments will increase both productivity and satisfaction.

Previous Work: The term "intelligent space" has been given various definitions by researchers in the ubiquitous computing field. The shared goal of much of this work, however, has been to integrate technology seamlessly into an environment so that users are able to focus more on their tasks than on the technology in support of their tasks. Hanssens [5] describes recent work on the MIT Intelligent Room project; Coen [3] describes an earlier version of the MIT project. Streitz [8] uses the term "roomware" to describe computer-augmented objects that result from integrating room elements (e.g. walls, doors, tables, chairs) with computer-based information devices. The Bluespace research program at IBM has studied intelligent spaces in work environments. Based on workplace studies carried out at Steelcase, the IBM researchers explored ways in which ubiquitous computing technology could enhance the work cubicle [2]. Much of the current research on intelligent spaces draws inspiration from earlier CSCW projects at places such as Xerox PARC [9] and Lancaster University [1].

Other related work has focused on using "intelligence" in an architectural sense to improve the quality of indoor environments. To increase productivity of individuals and organizations, studies have looked at automating control of lighting, temperature, and other environmental factors, and in aiding in the placement of physical elements such as walls and windows (e.g. [7]). Other studies have looked at how the design and use of ergonomic and easily configurable furniture can improve interior space. Workplace studies have shown, for example, that people are more productive in flexible workspaces that can be dynamically reconfigured to support different tasks (e.g. [6], [10]).

Approach: We are rebuilding an office in our lab as a prototype of an effective intelligent workspace, one that takes advantage of novel technology and modern interior design practices. We have informed our design of the space by observing how people use their offices and by studying literature on workplace habits. In addition, we are incorporating technology developed as part of our Intelligent Room and Visual Interface projects. This technology also is being used in several AI Lab faculty members' offices, where it automates visual presentations and controls lighting. The offices will afford us the opportunity to try out our ideas in additional workspaces.

Working from scenarios that we developed for how an intelligent workspace might support collaborative work, we are focusing on three areas of research. First, we are exploring the use of mobile furniture to create a dynamically reconfigurable workspace: as the physical arrangement of the space changes, the technology supporting the space

should accommodate accordingly. As the figure below suggests, a work surface may have a stationary component and a mobile component. A round table, shown in gray, docks into a corner table as an extra surface for personal work, or can be moved out to accommodate a small meeting. As a result of the move, the workspace should automatically reset the default display area, for example, and change the lighting. Our second area of research focuses on tools to enable this sort of dynamic reconfiguration: we are developing novel computer vision and other sensing technologies for inferring activities in a space [4]. With knowledge of the tasks in which a person is engaged, applications can offer relevant assistance. We plan to explore the use of such applications in simplifying everyday office tasks. Our third area of research focuses on the study of how people use an intelligent workspace such as the one we are building. We plan to continue our workplace studies by having people use the space for extended periods of time, thus allowing us to evaluate our work and to engage users in an iterative design and development cycle.

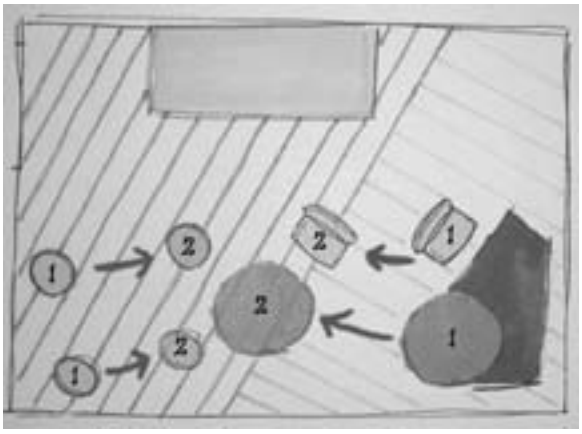

Figure 1: In our intelligent workspace, moving the table and chairs from position 1 to position 2 signals a change of task. The workspace should automatically reset the default display location from the wall area nearest the desk to the wall area nearest the table.

Impact: Intelligent spaces will prove invaluable in our daily lives if attention is focused on both the technology in support of daily tasks and on the physical space requirements. With intelligent workspaces in particular, we will be able to simplify everyday office tasks and increase both productivity and workplace satisfaction.

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