CLever

Building Cognitive Levers to help people help themselves

An L3D Project funded by the Coleman Family Foundation / Coleman Institute

Progress Report April, 2001
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The mission of the Cognitive Levers, or CLever project is to provide computationally enhanced environments to assist people with a wide range of cognitive disabilities and their support community.

We believe that individuals can (and in some cases must) follow very different learning paths. Our goal is to respond to that challenge by creating environments that match individual needs and learning styles. It is our hope that people at all cognitive levels, ranging from severely disabled to extremely gifted, will greatly profit from the conceptual frameworks and systems that we are developing.

The dimensions depicted in the above figure are important to disabled people as well as to the people supporting and helping them (e.g., parents, teachers, and community groups). The L3D team is firmly convinced that the nature of the problem along with the challenges will require a socio-technical approach.

Our Research is focused around three major areas:

- *theory development*, including comprehension support with narratives, visualization and personalization, and collaborative knowledge construction;

Contact Information

Gerhard Fischer  
gerhard@cs.colorado.edu

Andy Gorman  
agorman@cs.colorado.edu

L3D  
http://www.cs.colorado.edu/~l3d

Intellectual core and vision of the L3D approach to “helping people help themselves”. Empowerment, augmentation, inclusion, and learning can lead to independence and are the critical dimensions and objectives of our project.
• community building, including collaborations with teachers, parents and health care professionals, along with the creation of physical and virtual meeting places

• system development and assessment, including toolkits supporting universal design and collaborative web technologies.

Some of the following specific research topics will be addressed:

• people with disabilities form "a universe of one" requiring research in personalization, user modeling, and adaptation

• different learning paths are needed to match individual needs and learning styles

• individuals with special educational needs and very different cognitive abilities offer a unique window into understanding the human thought processes in general, which will require research into new models of human-computer collaboration

• research to support lifelong learning, and development of an infrastructure in which task-relevant knowledge can be shared (e.g., teachers and parents do not have the time and the knowledge to identify the most important devices and explore their adequacy to specific needs).

This document summarizes work on several investigatory projects that have contributed to the broader CLever project over the last 6 months.
QueryLens (Shin’ichi Konomi)

Introduction

A major research interest in the group is in the development of simple and intuitive user interfaces for sharing and manipulating complex information spaces. This is particularly important for people with cognitive disabilities who need a simple, intuitive interface, but it will also benefit the general population. Passage and QueryLens are examples of efforts towards such a user interface. The Passage mechanism allows users to transfer digital information by simply carrying and transferring physical objects. QueryLens allows users to share and obtain useful information using mobile handheld devices. Users can simply look at a physical object through a “digital lens” in order to retrieve (and attach) queries (and information) that are relevant to the object. I believe that mobile technologies can do better than now in assisting wide range of people including the disabled and their support community.

Development of a mobile information sharing environment

The current prototype of QueryLens had been developed extensively from December 2000 till February 2001. As shown in Figure 1(a), it uses a Palm device (Handspring Visor), its extension module that reads wireless tags, and wireless tags. Figure 1(b) shows a screen (with a small “Q” at the center) that is displayed immediately after the device recognized a wireless tag. Then it expands (Figure 1(c)) till a query is displayed on the screen. Figure 2 shows different types of information displayed by the QueryLens. It can handle SQL queries so people can change other people’s SQL queries and execute them. Also, it can control PCs to play multimedia files and display URLs.

Figure 1: Reading a wireless tag with QueryLens

Five video clips were made to demonstrate the system. One of them explains features of the system. This is the only clip in Japanese. Other clips are all in English and describe usage scenarios (office, library, grocery shopping, music CD shopping). Figure 3 shows some image snapshots from the video.
In the next steps of QueryLens, there is a larger goal of realizing a “pervasive query environment” (called Q-Anywhere.Net). Possible future activities include improvements of QueryLens, the development of an environment that bridges the information space of QueryLens and the Internet, and the development of a smart environment that surrounds QueryLens and its users (along the same line as Roomware and Cooperative Buildings -- and tries to achieve Mobility for All).

Getting Around in Tokyo with mobile technologies

Pervasive computing is already becoming a reality. For example, in Shibuya, Tokyo there is an area called “bit valley” where there are a number of small young high-tech companies and it’s also a center of youth culture. The trains in Shibuya have approximately 2 dozen LCD monitors, one in the second car of each train (Figure 4). These monitors display news, weather information, ads, etc. While these first appeared about 10 years ago, it seems that most people are not paying much attention to them.
Several companies sell timetable databases and travel planning applications (like the RTD travel planner). One that can run on a notebook includes databases of almost all trains in Japan (so no wireless connection is required.) However, using a notebook computer at a train station, on a train, or while walking is too cumbersome for the average user. Using a small handheld device might be a more effective approach.

Another (free) application is called TRAIN and it runs on a Palm. It is a sort of a travel planner application. Users need to download “train data” for a specific area before using the system. The software tends to display too many alternative routes and users who are not familiar with the train system have a hard time figuring out which routes can be deleted from the list.

In the past few years, NTT replaced public pay phones with new machines (Figure 5) that read wireless tags (as pre-paid phone cards) and communicate with PCs and handheld computers via Infrared. Users find it much easier to access the Internet using a Palm and one of these machines than using a notebook and an older pay phone.

*Figure 4. monitors in a train Figure 5. new public pay phone*

**Future Directions**

This report has introduced QueryLens and some preliminary forms of pervasive computing environments in the "real" world. QueryLens needs to be extended in order to support people with cognitive disabilities. Possible extensions include uses of image, audio, and animation for representing information and adaptive displays to support an individual’s specific needs. The examples of information infrastructure found in Shibuya, Tokyo indicate that the basic technological components already exist to realize the visions and scenarios of the Mobility for All project and, in particular, Stefan Camien’s MAPS system, which are both described later in this report.

**MAPS Memory Aiding Prompting System (Stefan Carmien)**

Cognitively handicapped individuals are often unable to live on their own because of their inability to consistently do normal domestic tasks like cooking, taking medications, personal hygiene and other tasks. A common way of transitioning from assisted living (or living with ones family) to independent or semi-independent living is thru the use of prompting systems. Several computer based prompting systems have been created for home living, with some success. Transition professionals identified the
home as one of these four broad areas where prompting can be of use: community, recreation, vocational and domestic.

Looking at this list it is clear that there is a need for extending these systems to outside-the-home environments. A prompting system that can be hand held, robust and effective would be clearly a win in an established, proven area of successful techniques.

In the existing systems I have studied, and in fact in general for all Assistive computer-based technology (including and especially in Augmentative and Alternative Communication (ACC) devices), a major contributory factor in non-adoption or short-term only use, is difficulty in initial configuration and modification of the configuration of the device. Some experts estimate that as much as 70% of all such devices and systems are purchased and not used over the long run. By viewing the configuration and other caretaker tasks as a separate and equally important interface, and by applying techniques such as task-oriented design, this problem could be mitigated.

Additionally there is a lack of small granularity information about the actual use of the tools, for adjusting configuration, long-term evaluation of the user/device/configuration match and research purposes.

Typically the use of these assistive computer systems include three roles:
  • end user (the handicapped person),
  • caretaker (family or institutional person), and
  • technology expert (this may be a team of domain experts but will typically be one installation/configuration person once the system is chosen and purchased)

By designing a System – including easy to create and modify prompting scripts, these small ‘atomic’ groups could be connected through the medium of sharing and modifying scripts in repositories of scripts. This could add the well known leverage of an open source tool as well as providing a immediate reason for creation of a forum of users, caretakers and designers that could also assist in overcoming the insulated life that these problems often cause (e.g. there is a very high divorce rate amongst parents of similarly disabled children).

The size of the problem can be glimpsed by the following quote from the web page of The ARC (www.thearc.org) a group devoted to the issues of mental retardation (a major subset of the targeted domain of the cognitively handicapped):

How many people are affected by mental retardation?
  • The Arc reviewed a number of prevalence studies in the early 1980s and concluded that 2.5 to 3 percent of the general population have mental retardation (The Arc, 1982).
  • Based on the 1990 census, an estimated 6.2 to 7.5 million people have mental retardation. Mental retardation is 10 times more common than cerebral palsy and 28 times more prevalent than neural tube defects such as spina bifida. It affects 25 times as many people as blindness (Batshaw, 1997).
  • Mental retardation cuts across the lines of racial, ethnic, educational, social and economic backgrounds. It can occur in any family. One out of ten American families is directly affected by mental retardation.

Prompting by trainers or with cards is an established technique used for both learning and repeating a task by cognitively handicapped adults. In my meeting with the Adam 12 high school to adult life transition group and with others prompting is presented as a
primary tool for both training in new tasks and as a scaffolding enabling ongoing task completion. There have been several papers on the topic of computerized prompting and cognitively handicapped by a European research group [Lancioni 99-00] and several others [Kim 00; Lynch 95].

This work was inspired by an existing commercial system called ‘Visions’. Visions is a stationary prompting system based on a Win95 machine, touchscreen(s) and speakers. Visions interacts with the user through sound prompts “time to get up” or sound & visual prompts (e.g. making a meal). The Able Link team (http://www.ablelinktech.com/AbleLinkFrameset.asp) has a product called ‘Pocket Coach’ that gives a series of vocal prompts running on a PDA using WinCE. The Issac project (http://www.certec/ith/se/English/Isaac/index.html) did much initial exploration of PDA’s for cognitively handicapped.

The design part of the project will make extensive use of King’s Assistive Technology-Essential Human Factors [King 1999] and Beukelman’s Augmentative and Alliterative Communication [Beukelman 1998] texts.

Underlying much of the proposed system will be concepts, basic to the L3D group, like aiding communities of practice, developing tools to make artifacts rather than simply artifacts, and an emphasis on an active engagement with the computational enhancement system by all stakeholders (http://www.cs.colorado.edu/~l3d/).

Initially the project will be involve the creation of a prompting system on a palm sized touch screen device that will be capable of displaying and vocalizing a series of steps to accomplish a task. This prompting can be elicited by a menu or triggered by a timer (or possibly remotely via IR). The initial task that the system will solve will be replacing the card system for shopping for weekly groceries in the Visions system. The system will be linear in the sense of one picture and prompt will follow sequentially after another, but will allow restarting and backstepping. There will be several levels of logging, from the ability to trace steps not taken on an immediate basis to long term logging for diagnostic analysis.

From this point further elaborations in the design could be interactivity with other ‘smart’ things – like bus stops that inform the user that the bus they wanted had just left or would arrive in 10 minutes. Other interactions could be ‘panic’ situations, here a GPS system could inform helpers of a ‘lost’ client or simple ACC functionality to allow interactions with sales clerks and systems like the EDC.

The interfaces for the initial installer and ongoing changes would be targeted at non-computer professionals, and be simple and intuitive. Doing this part right is, from the perspective of adoption of the device, as important as the user interface.

Currently, the project has purchased a PDA (a handspring Prism), sound and camera modules for it, the Codewarrior Palm OS development system. I am using a trial version of Sybase’s Adaptive SQP server and Ultralite PDA DBMS. I have determined and implemented the database schema using Sybase’s Power Designer tool and have worked through the sample Palm app code tutorial. I have written a high level modular decomposition of the PDA side of the application as well as a rough cut at the pseudo code. The next step will be the tool for creating and sharing scripts on the PC.

I am continuing my research into the literature on Assistive technology design and prompting. I have established a connection with the Adam 12 transition team to
provide real world feedback on my project as well as users (cognitively disabled, caretakers, technology experts) for evaluation. I am also working on getting the necessary authorization and documents from the university for doing research on humans. I expect to have a rough prototype this summer.

A possible extension of my project might be as part of an implementation of an ‘intelligent bus stop’. The PDS could interact with the bust stop or kiosk which would, in turn be connected to the Bus system and it’s knowledge of schedules and actual bus arrivals and also with a 911 style panic service that would assist a lost cognitively disabled individual. From this scheme many other possibilities come to mind: using the PDA as a ACC (Augmentative and Alternative Communication) device to interface the types of information that may present too high a conceptual hurdle, a telephone interface for difficult to use proprietary PBX phone stations, a smart wallet, etc.

References:


King, Thomas; Assistive Technology – Essential Human Factors Allyn & Bacon 1999

Beukelman, D, Mirenda, P; Augmentative and Alternative Communication (second edition) Brookes 1998

I-Mail (Leo Burd)

Introduction

The goal of the I-Mail (Inclusive Mail) project is to develop an e-mail client targeted at people with mental and/or physical disabilities.

The challenge is to develop something as simple to use as possible, providing the appropriate amount of feedback and support to specific users. For this reason, the I-Mail interface has been built around pictures and vocabulary that are familiar to the user (see figure 1) and many features present in
common e-mail tools have been removed (such as message priorities, mailbox creation), hidden (connection and specific devices setup) or automated (trash bin management).

Other challenges include dealing with an audience with very unique characteristics, specific technical constraints, and the novelty of the field itself. These challenges often require the adaptation or extension of traditional software requirement techniques.

In order to deal with these problems, the I-Mail development requires not only the involvement of assistive technology professionals, but also the constant interaction with the disabled in their real settings. Moreover, it requires the application of universal accessibility guidelines and a continuous assessment of the right level of personalization and scaffolding to be provided for each user in different situations.

In addition to helping people with disabilities have a more active participation in our society, it is worth mentioning that the I-Mail is expected to provide an easier entry point to the Internet for kids, the elderly, or anyone who is in the process of learning to read or write.

**Related work**

Currently, there are many communication devices developed to address the specific needs of the disabled. They consist mainly of special purpose text editors and picture-based tools that execute predefined operations upon the press of an associated button.

However, there seems to be a lack of Internet communication tools for this population. The only ones we could find were PapoMania, a chat tool developed in Brazil for people with Down Syndrome ([http://www.caleidoscopio.aleph.com.br/](http://www.caleidoscopio.aleph.com.br/)), and Inter_Comm, an e-mail client for people with special needs. Inter_Comm is part of an European Community project entitled ALDICT ([http://www.inclusion-europe.org/aldict/](http://www.inclusion-europe.org/aldict/)) and is been developed by Widgit Software LTD. ([http://www.widgit.com/](http://www.widgit.com/)). In 2001, Inter_Comm is supposed to be released in US market.

In our opinion, Inter_Comm is a very complete and mature product. However, its interface seems to be overcomplicated to part of the audience we intend to address and does not seem to be attractive enough for non-disabled people decide to use it. We believe that, in order to facilitate true inclusion, tools should be built according to the principles of universal accessibility ([http://www.universaldesign.org/](http://www.universaldesign.org/)) and be the least discriminatory as possible.

Rather than a pure assistive technology tool, we would like I-Mail to be recognized as an e-mail client for everyone.

**Our approach**

The development of the I-Mail follows the Task-Centered Design approach as described by Lewis and Rieman ([http://home.att.net/~rieman/jrtcdbk.html](http://home.att.net/~rieman/jrtcdbk.html)) emphasizing a close user participation in the entire process. However, most of the traditional techniques proposed cannot be applied directly to users with cognitive disabilities.
As a means to minimize this problem, we decided to base our initial work on expert advice and observation of users dealing with other devices. As soon as we have an operational prototype we will be able to carry direct tests with disabled users.

We foresee the I-Mail as a system composed of the following components (see figure 2):

- **I-Mail client**, which will provide personalized interface to the e-mail functionality
- **Mail component**, which will deal with e-mail message transmission and storage mechanisms
- **Text-processing engine**, which will select and incorporate adequate pictures and sound to existing text messages
- **Pictionary**, which will handle picture dictionaries
- **Address book manager**, which will control possible message destinations
- **Profile manager**, which will provide means for managing users and configuring various I-Mail settings.

We believe this architecture will facilitate future system extensions – such as word prediction and speech-to-text message composition – and component reuse by other technologies being developed at the Cognitive Levers Project.

**Current status**

As we the quality of the user interaction with I-Mail is probably the most challenging aspect of the system and the key for its success, at this stage of the project we are developing mockups of the interface and clarifying specific user requirements.

More specifically, so far we have developed a static mockup of the I-Mail user interface and are currently working on the Profile Manager mockup. The I-Mail mockup was developed with intense collaboration of special education teachers from the Boulder Valley School district.

The Profile Manager mockup is being developed with the help of experts from the Denver and Boulder area. We have carried seven interviews with them and visited their organizations. We have also identified and described basic tasks to be supported and are now defining scenarios and mockups to address them.
Once we finish the I-Mail and the Profile Manager mockups we will have a very precise definition of the system’s user interface and requirements. As mentioned above, with the mockups done we will be able to start developing the real product and carry tests with disabled users.

**Concerns**

So far, we have identified the following points:

- The need for an in-house expert in disabilities and augmenting technology. Most of the basic questions we have could be solved with the help of an expert like Anja working with us. It is very time consuming for everyone if we have to go to the schools all the time to ask for simple things.

- The need for an official partnership with the Boulder Valley School District. Even though teachers have been extremely collaborative, we understand that they are very busy and that we are using time that they would otherwise use for their personal activities. It would be very nice if they could have the I-Mail tasks as an official part of their duties.

- The usage of commercially available software. Even though there are no official standards for picture libraries, most people seem to use the ones provided by Mayer-Johnson (http://www.mayer-johnson.com/) and other major assistive technology developers. Ideally, I-Mail should be compatible with them. This may require an official agreement with these companies.

- Software distribution. Almost every teacher we interacted with asked how much the software would cost and how it is going to be advertised and distributed. Ideally, it should be made very accessible, but how distribution policies are going to be implemented is something beyond the scope of the I-Mail development team.

- Undergraduate student’s involvement. It would be very nice if we could have undergraduate students working in the team. In special, the developing of the real product will require more people than we have available today and this may provide a good experience for the students.

**web2gether project (Rogerio dePaula and Eddie Caley)**

**Introduction**

Recently, new ways of collaboration and sharing (from knowledge to software applications) became possible with the development and widespread use of the Internet. While, the web technology has not replaced (and will possibly not) traditional social interactions, it has shown to have the potential of facilitating, extending and even enabling them by socio-technical means that would be not possible otherwise. To name some, the web has provided great opportunities for distributed collaboration to take place more efficiently and effectively; it has allowed teachers, parents and students as well to have access to a wealth amount of...
information, which allow them to learn, say, by bringing together different perspectives on any learning topic; and it has allowed communities to effectively share and collaboratively discuss new information, new practices and new technologies. In sum, the web technology has a great potential to help those who support the while community around individuals with disabilities find, share and learn new ways of using assistive technologies, and equally important see themselves as part of a community.

At schools, however, it has been observed that to have teachers using and adopting computer technologies in classrooms to help students (with disabilities or otherwise) accomplish some learning activities turned out to be a difficult task. First, there exists no comprehensive pool of applications in which teachers would easily find a specific application required to support specific student’s needs. Second, teachers may not have the time, the technical expertise or the motivation to go out searching for, downloading and installing those applications. Finally, when they get to access those materials (via the Internet or otherwise), they usually have problems deciding or assessing which application would be the most appropriate, based on the problem at hand (the kind of disability a student had and the class activity in which she wanted this student to be involved) and the information offered by the application providers.

The problems that teachers face are twofold. First, there is no comprehensive repository of those applications and activities—it is hard for them to find information on the Internet, and most of the time they have neither time nor motivation to spend searching and understanding the materials. And the difficulty of mapping their specific problems at hand into the software specifications/descriptions—mismatch between teachers situation model (the way they make sense of and represent their problem at hand) and the system model (the way developers represent their products).

**Existing Projects**

In an attempt to facilitate the adoption of assistive technologies, the Boulder Valley School District (BVSD) assistive technology team (ATT) collected over the Internet several freeware and shareware applications, and put them onto a CDROM. Those are software applications that they found to be of some relevance for supporting students with some kind of cognitive or/and physical disabilities. Interestingly, most of those applications were not necessarily developed for this audience; some are in fact sample games, simple shape manipulation software or promotional applications, developed for the general public. However, based on their experience working with this group of students, the ATT realized the potential of those applications to help students learn, say, basic mechanical writing skills, stimulate sensory responses, even motor coordination and the like.

The next question is then how a teacher would be able to select the most appropriate software to support a specific classroom activity. There are basically two complementary assumptions, in the design of the current version of the CD. First, the
ATT themselves would play an important role in helping teachers find out the most appropriate software application. Second, since teachers know their students (their abilities, mental level, skills and so on), they would be able to determine whether an application was likely to support these students, as they explored the CD. However, in order for the latter process to happen, teachers would have to be able or to be willing to take the time to explore the CD, and learn about each individual application. Though this may occur, it is more likely that they will rely on ATT, at least in the beginning. In this respect, the adoption of the CD will highly depend on the active participation of the ATT, and teachers’ availability and willingness to explore the CD.

It is however usually the case that the ATT is not always available to support each individual teacher when they need, and the teachers do not have much time available to explore those applications. (In the case of other users, such as parents, they may not have the necessary background to be able to discern the most appropriate application for their child.) Moreover, applications rapidly become obsolete or incompatible with new operating systems, new ones become available in unknown places, and users find out new ways of using applications in different settings. Therefore, in order for applications to become more useful to users, it is essential to develop tools that help users search for applications and actively participate in a community with other users.

Besides this important attempt by the ATT, there exist commercial catalogues of educational application (online and otherwise), targeting very specific audiences, and scattered specific community supported web sites that usually provide links to commercial applications. However, none provides comprehensive mechanism for searching & browsing and collaboration.

### Problems with the CD approach:
- to have teachers motivated enough to actually use the CD
- to make the repository evolvable
- to make it a collaborative effort
- to exchange other experiences, updated or new applications, activities, and so on...

**web2gether project**

This project aims to allow a community of teachers and parents of cognitive disabled children to find software applications that are most relevant to their problem at hand and allow them to share and learn more about their practices, experiences and knowledge within a community of learners and practice. The key challenges are as follows:

- To facilitate the formation of a community by understanding current social practices and networks amongst teachers and parents. To do so, we aim to better understand their social networks and working environment
- To understand how they think about their problem (their problem space), so as to help mapping that into problem space of application’s developers (one should note that these applications are mostly adapted technologies).

In so doing, it aims at developing a collaboratively built and comprehensively organized repository of assistive software applications. That is, the challenge is to
design a system, which while facilitates the adoption of those applications by teachers within their classroom settings, it also allows non-experts, such as parents, to have access to a comprehensive repository of those applications. It is also an aim to build and sustaining a community of educators, parents, students with special needs and researchers around the use and exchange of those software applications. To this end, it will develop mechanisms that allows them to find the most appropriate applications, that helps them choose applications according to their specific needs and context, and exchange stories, experiences and practices.

**Audience & Assessment**

This project initially focuses on supporting teachers, parents and caretakers of students with cognitive disabilities. To this end, we have been carrying out interviews with special education teachers and the assistive technology team in the BVSD, and observing their current working practices and environments (technical and otherwise). In addition, we are applying participatory design techniques for better understanding their social practices and networks. Finally, we envision using participatory analysis techniques to evaluate the impact and effectiveness of the system in teachers’ working practices, and social networks.

Another important goal of this project is to have eventually students in general using the system, and sharing their personal stories and experiences in using software applications, which would bring about another relevant perspective to the community.

**Future Developments**

As future development we would like to address two complementary aspects of the project: social practices and technology. We believe in the importance of understand the following social issues:

- Teachers’ working environment
- The nature of learning communities
- The role of culture in design

**Major goals of the Project:**

- A collaborative & evolvable repository of software applications
- A comprehensive & collaborative retrieval system to help to find software applications
- Help create a culture of collaboration among teachers and parents to create and sustain a community.
• The role of stories in supporting community formation
• How to foster a sense of community

In addition, we have been developing the following technological components:
• The initial web-based repository of software application, based on WebLogic and Java Servlets & JSP’s. This will allow reusable components to be factored out of Web2gether and into the SPIDER framework described in the next section.
• A collaborative and comprehensive information retrieval (IR) system that tightly integrates searching and browsing components, based on:
  o Retrieval by reformulation mechanism
  o Bayesian networks (probabilistic approach for IR)
  o Social Navigation
  o Social Filtering

Finally, we want to carry out usability tests with teachers at school and develop usability tests for collaborative work mediated by technology. To this end, we have extended the traditional task-oriented design methodology to address the overall framework of social creativity, which involves the following issues:
• universal usability,
• user modeling,
• participatory design
• comprehension and
• community-centered design

SPIDER (Andy Gorman)

Introduction

In today’s information rich world the problem people face is not one of limited information, but rather it is one of a limited ability to attend to an overabundance of information. Sharing information within a single work group or community is difficult enough. The problem is compounded when it is desirable to share information within and between groups. In this case all groups share a common interest or goal, but each group has its own unique focus. Achieving the common, overarching goal shared by all requires the interdisciplinary collaboration of all workgroups (e.g., computer science, health science, cognitive psychology, speech pathology, etc.).

Now consider a different, but analogous problem. A quick look at groups.yahoo.com will show no less than 600 discussion groups under the heading “Cultures & Community > Groups > Disabled.” It is desirable for each of these groups to maintain their unique identities, but there may be many groups that have information relevant to any one individual. The groups have become so specialized (e.g., “Cultures & Community > Groups > Disabled > Special Needs Families > Downs-Heart” a contact point for families who have a member with Down's Syndrome and associated
congenital heart disease.) that an individual would need to monitor several groups to keep adequately informed.

A system that provides a single information gateway or portal that satisfies a user’s need to maintain his or her unique focus while simultaneously monitoring the activities of related but distinctly different communities would be a valuable tool. **SPIDER** (Sharing Pertinent Information in Dynamically Evolving Repositories) is an attempt to create a substrate for building such a tool.

**Related Work**

One tool that recognizes the need to maintain an individual and group perspective is WebGuide [Stal, 1999]. However, WebGuide is designed to be an *intentional* knowledge building tool. In other words, the goal of using the system is to build new knowledge. In the work group example described above, any system that requires an additional deliberate activity will have a decreased chance of being adopted. The communication needs to be in the background and part of the users normal work practice. The value added should be a byproduct of that normal communication.

DynaSites [Ostwald, 2001] is another system for cultivating organizational memories. While this has been successful in many situations, it has some of the same drawbacks as WebGuide. Furthermore, because of its monolithic design it is not easily extended and adapted to suite new application needs.

A fundamental problem that arises when considering the adoptability of a new system is highlighted by the question, “Who does the work and who gets the benefit?” [Grudin, 1987; Grudin, 1988] Another way to view this is by looking at the utility of an application. Utility can be expressed as utility = value/effort. One way to increase a system’s utility is to decrease the effort required of the user. GIMMe [Lindstaedt & Zimmermann, 1995] is an organizational memory system that made such an attempted. Even though the effort to add information to GIMMe was low (data was extracted through normal email activity), the perceived value of that information, as organized by GIMMe, was also low. Therefore, the goal of an organizational memory system that supports individual->group->organization hierarchies is to provide both a low threshold for use and some significant perceived value.

**Proposed work**

SPIDER will not be a single system or group of systems. Instead it will be a collection of components, built using the J2EE standard, that will enable the rapid deployment of web-based applications for the support sharing information within and amongst groups. SPIDER will be built on top of BEA’s WebLogic servers, which provides a robust implementation of the J2EE specification, but is not specialized to the types of groupware applications we wish to support.
In addition to providing support for groupware applications, many of the projects under the umbrella of the CLever project will need back-end server support and front-end client support. As shown in Figure 1, these applications will be build on top of the SRIDER framework. The framework and application layers will be constructed in tandem. As applications are developed, an effort will be made to identify reusable components. These components will then be factored out of the application and into the SPIDER framework. Taking this approach will allow application development to proceed unencumbered. As the applications reach stable milestones, common functionality can be identified and built into the SPIDER framework. The next generations of applications can then build on the framework when appropriate. As new functionality is needed in an application, the decision can be made as to where to put the new functionality—into the framework or directly into the application.

**Current Status**

SPIDER is still in the conceptual phase. We are also beginning to get up to speed with the technology (i.e., WebLogic and EJB). We are beginning to build relationships with others in the CS department whose own research will benefit the SPIDER project. These include Jim Martain’s work with Information Retrieval (IR) (Rogerio dePaula exploring this avenue in the context of the Web2gether project, described above), Mike Mozer’s work in Machine Learning, and Roger King’s database work. However, these relationships are still tentative at this time.

Upcoming meetings with Mark Dubin (cognitive neuroscience) and Bruce Henderson (Journalism and Mass Communications) will take place in the near future. The focus of these meetings will be to discuss the development of the CLever Portal. One preliminary idea is to develop a central gateway, or portal, into all the myriad of news groups that exist to support communities affected by disabilities. This portal project will help lay the foundation for the SPIDER framework.

Recent meetings at BEA’s Boulder office helped establish relationships that will enable better technology transfer between the two organizations. It will help our group get up to speed with the BEA technology.

**Future Directions**

The next step will be to complete the WebLogic Personalization Server installation (there are still a few hang-ups). After we become more comfortable with the BEA products, by working with the folks in the BEA office, it would probably be productive to have some formal, in-house training.
In the longer run, we should think about increasing our staff. We should dedicate part of our budget to hire some of Bruce Henderson’s students from Journalism and Mass Communication to develop the Portal content (e.g., feature stories, interviews, life stories, etc.). We should also earmark funds to hire or contract graphic artists to make to portal more aesthetically appealing and authoritative looking. Additional programmers, perhaps as undergraduate projects, will also be desirable and since EJB development lends itself to medium-sized, well-defined projects, a senior project might be the right course to take.

References


Interfaces Supporting Direct, Collaborative Interaction (Hal Eden)

In the context of the Envisionment and Discovery Collaboratory, we have been working to create an action space that supports more direct interaction with computational simulations by a group of individuals in a face-to-face setting.

Whereas initial prototypes of this were based on a touch-screen technology (SmartTech’s SmartBoard) placed in a horizontal orientation, which afforded insights into important aspects of the around-the-table interaction, several limitations became apparent, such as the lack of simultaneous interactions and the inability to create interaction behaviors more closely tailored to the objects the user is interacting with.

We are currently studying the use of a technology created for use in electronic chessboard (by DGT Projects, NL) that allows several objects (with embedded transponders) to be tracked simultaneously.

In addition to the use of this technology to support groups interacting around a design problem, we are exploring how these devices could support the efforts of the CLever project. One aspect of this support is certainly by providing a lower threshold for use (more direct and concrete, less abstract), allowing a broader range of individuals to join into the collaborative activities.

Other possibilities that are being investigated include:

- i-Mail “Direct”—extending the i-Mail project to support the creation of messages using concrete objects (e.g. in addition to the pictures on the screen, physical version of those pictures could be laid out on the board to interactively compose the messages).
- Bus trip planner, tied into the “mobility for all” showcase. The current work on “the Bus Stop” could be extended to create a way for people to interact with RTD’s on-line trip planner, develop plans for a trip (when and where to meet the bus, when and where to change buses, etc.) by directly interacting with concrete representations of personal landmarks superimposed on the available transportation maps. These travel plans could then be stored in a PDA or smartcard and be used to interact with bus stops, buses, and bus-drivers to provide assistance with the trip.
- A prompting system support environment, including the caregiver and the end-user in the creation and evolution of meaningful prompts and interventions.
“Mobility for All” — A Socio-Technical Design of Human-Centered Public Transportation Systems

CLever Research Project Team and Collaborators
Ernie Arias, Leo Burd, Stefan Carmien, Rogerio de Paula, Hal Eden, Gerhard Fischer, Andy Gorman, Anja Kintsch, Shinichi Konomi, Jim Rebman

and contributions from
Cathy Bodine, Faye Byrd, CommArts Inc, Jonathan Ostwald, Jim Sullivan

Remarks:
1. Based on our extensive work with Envisionment and Discovery Collaboratory (EDC) and its primary application domain of Urban Planning and Transportation (and our initial collaborations with the City of Boulder, the RTD, the Boulder County Health Department, and the Boulder County Healthy Community Initiative), the concept of an “Intelligent Bus Stop” appeared early in our work as a nexus application of the Clever project (and it was extensively discussed during a Clever retreat in June 2000 in Estes Park).

2. The ideas to develop a support environment based on a personal digital assistant emerged early in our project as a natural extension in response to the Vision system (a stationary system supporting people with disabilities in their desire to live independently).

The Problem Statement
To be mobile is difficult for people with disabilities — but it is a need (e.g., to go to work) and a desire (serving as an indispensable enabling condition for inclusion and independence, two of the overarching objectives identified for the CLever project; see figure in title). In most cases, people with disabilities will not be able to use automobiles or bicycles, so public transportation systems are their only choices. But current public transportation systems have numerous limitations (as has been documented in the literature and as we are identifying further in our research) that make it difficult for people with disabilities to use. We are in the process of engaging in a major socio-technical design activity to explore, design, implement and assess components of a more human-centered public transportation systems.

Early in our research approach, we identified the “space program” effect (or “dual use” aspects) as fundamental dimensions of our approach. We are firmly convinced that the research outlined in this document will have broad implications:

• for much more diverse communities, such as elderly people, children, out-of-town people not knowing a city, and foreigners not speaking the local language;
• for other problem domains and everyday activities (living independently, shopping, etc);

• for new conceptual frameworks (e.g., finding the best distribution of responsibilities and activities in collaborative human-computer systems for

• for new technologies and their integration with each other and serving as a component in the larger social system

Figure 1 gives a envisioned scenario as an “intelligent bus stop” human-centered public transportation systems.

Figure 3: Human-Centered Public Transportation Systems — Envisioning an Intelligent Bus Stop

**Design Approach for Human-Centered Public Transportation Systems**

While this research project will explore a large number of new conceptual frameworks and new technologies, we understand it as a socio-technical problem. In order to avoid the problem which many system developments encountered, namely “Built it and they won’t come”, we will explore “how things are” and we will use the insights gained as important requirements for “how things can be”.

**How things are — Understanding the Current Situation**

**Built it and they won’t come.** Our project will identify and work with users and their representatives. More than once, research projects have experienced the frustrations and breakdowns associated with building technologies and then trying to enlist users (who we think should see our technologies as the answer to their problems). The energy and sense of purpose must come from working from the user's problems first (and thus engaging them as informed participants, an important objective of our work pursued in
the context of the Envisionment and Discovery Collaboratory (EDC) are the most important factor in making this project succeed. (Note: This approach tries to avoid the well-known problem corresponding closely to the statistic that about 70% of all assistive technology purchased is not used.

Appendix 1 contains an “interview” with Jim Rebman, a member of the CLever project who is blind and who has provided us with numerous insights into problems which people with disabilities face and he has served as an invaluable resource to point us to existing approaches.

We will collaborate with Faye Byrd (and her colleagues). Faye is a specialist in helping cognitively disabled persons with the transition from school to independent living in the ‘real’ world. In addition we will interview and “shadow” members of target population using our collaboration with the assisted living center in Boulder.

Initial Assessment of the Intended Users Community

**Jim Sullivan:** In our initial discussions, we reflected on three different classes of users:

- **Users with degrees of sensory impairments** (blind ↔ vision impaired, deaf ↔ loss of specific frequencies etc.) While users in this class may have one or more deficits in a particular sensory channel, they may also have heightened acuity in a complementary channel (i.e. a vision impaired person may have heightened auditory and tactile senses). More importantly, a person in this class will not necessarily have any difficulty processing information unless the desired information is in a form that is overwhelming to their complementary sensory channel (i.e. a blind person getting lengthy audible directions from a someone with a strong accent – a non-sight impaired person might ask “could you please draw a map”). A person in this class would also likely know when they need help – and be able to communicate with others in the world to confirm their situation and request assistance. Finally, a person in this class would likely be able to comprehend and follow instructions to recover from a unique mistake or system error as long as it was encoded in a complementary sensory channel.

- **Users with cognitive deficits** (occasional errors when processing information ↔ completely unable to process any information). Meegan in Stefan’s scenario (see Appendix 2) falls into this category. This person has vastly different needs than a person in the previously discussed class because:
  1. They may not know when they need help.
  2. They may not be able to understand when help is being offered by a non-trained or unfamiliar person
  3. They may receive cues from the “noisy world” around them that causes them to “panic” and deviate from the “plan” even when everything is going well.
  4. There may be lapses when they are unable to perceive or process even well-designed cues that they have been trained to recognize and thus get into unplanned or unsafe situations.
  5. **claim:** designing a system that is safe, reliable, and robust for this class of user is a significantly greater challenge.
• Users who are a mix of the two classes above, such as an elderly person experiencing both failing eyesight and a weak memory.

CLever will further explore the question of “who is the intended user in this project” so initial design work can be properly focused. The other classes of users (there are many more than those articulated here) must also be identified and acknowledged - and would logically be the focus of future research after experience was gained in a tractable user subset.

Rogerio dePaula: This project will primarily focus on the interaction between parents & caretakers and people with cognitive disability. The goal of the project is to design and develop a system based on PDA’s, context-aware database server, and a web-based management tool, that facilitate the coordination of daily activities of this population. The major players would be:

1. Parents and caretakers – helping them coordinate and manage this population daily activities (they are linked close with the “panic button”)

2. People with disabilities – helping them cope with their special daily-life challenges so that they can become more independent

3. Researchers – helping them better understand how effective those artifacts are in facilitating coordination in (physically) distributed environments; and the effectiveness of integrating not only different technologies, but different modes of collecting context-aware information as well as representing such information.

Other Views How Things Are

Cathy Bodine: Easter Seals had (has) a transportation grant to assist folks with cognitive disabilities. Lee Carter was in charge the last I heard (303) 233-1666. Honestly, I’m not sure how things ended up, but finding individuals who jumped on the wrong bus used to be quite an issue! Thinking about a potential ‘tracking’ feature might not be a bad idea. I also like the kiosk component. We’ve been working with some older adults who reside in nursing homes and assisted living facilities. Their biggest needs are enhanced font size for vision, with capability to adjust easily (see Bigshot software) and an ABC layout on the keyboard (Intellikeys is a favorite for many). A human factors friend of mine did some research a while back on ATM’s and figured out that those over 55 prefer five or fewer functions (I think we talked about this at one point).

Anja Kintsch: The “Cognizant Bus stop” (see Appendix 2) will be part of a bigger system, at least in part working with a Visions like system in the home. It will be a “Mobile Prompting System” which works similarly to the Visions system for people on the go.

In this project, we need to be constantly providing feedback to users that they are doing things right (or wrong). The palm needs to indicate that yes, they are facing the right way before many users are going to be ready to receive the information regarding when or if the bus is coming. In addition this feedback, or any other information being given, needs to be provided in a variety of ways depending on the user (→ personalization). Some of us are auditory people, others visual and other kinesthetic. We prefer different ways of processing information and are better with certain types of "input" than others. This is even more the case with people with cognitive delays. While their eyes or ears may
"work," their mode for accessing information may be limited. Often parents/teachers ask if a child is blind or deaf because they don’t seem to pay attention to certain stimuli. For example I have worked with students who are somewhat verbal, imitate songs, show that they understand a lot, but are completely unable to use pictures to communicate or learn from. Others can use pictures to develop a story or user pictures to communicate, but can't get anything from a story being read to them or understand what is begin asked with them. For students like this we use sign language and pictures to tell them what we want them to know.

How things could/should be — Envisioning the Future

Appendix 2 provides a detailed scenario of some aspects of our envisioned human-centered public transportation systems including the following technology enrichments: personal digital assistants, GPS, wireless communication, smart bus stops, smart buses, computational support for bus drivers. An important component of the overall design is a “panic button” for lost cognitively disabled individuals with which they have access at any time to the human support environment.

Collaborations

- **Communications Arts, Boulder** — we have started a dialog with this Boulder design firm which has made major contributions to the design of public transportation systems.

- **AbleLink Technologies, Inc, Colorado Springs** — Research related to Palmtop Prompting System. AbleLink is developing the Visual Assistant(TM) (Patent Pending) based on their Visual ImPact system (formerly PictureCoach)).

- **Extend our existing Collaborations in Urban and Transportation Planning** — with City of Boulder, the RTD, the Boulder County Health Department, and the Boulder County Healthy Community Initiative.

- **Stephen Fickas, University of Oregon** — Stephen Fickas is in the process of creating a major research effort to support people with cognitive disabilities and our research efforts will benefit from a close collaboration.

- **“Collaboration with the University of Colorado bp Center for Visualization:** The CLever Project Team has initiated discussions with Geoffrey Dorn from the bp Center for Visualization. We believe there is great potential for design synergies with this new technology center now under construction. The Center for Visualization will have 3D virtual technologies that support an “immersive” evaluation of system prototypes with designers and potential users. This technology is complementary to the two dimensional interactive “plan view” simulation technologies currently under development by the L"D research group and on display in the Envisionment and Discovery Collaboratory. These complementary modeling and simulation technologies have the potential to yield tremendous insights and feedback about design issues and tradeoffs that would not normally be possible until after an initial prototype is built.
Design Phases

We currently envision and have planned the following phases (we will intertwine these steps rather than following them in a linear order):

Step 1: increase our understanding of “how things are” (see above)!

Step 2: build on our experience with the Envisionment and Discovery Collaboratory (EDC) as an design environment for informed participatory design and the strategic collaborations with the City of Boulder, the RTD, the Boulder County Health Department, and the Boulder County Healthy Community Initiative).

Step 3: explore the potential of new technologies and new environments:

- personal digital technologies (see scenario in Appendix 2)
- ChessBoard (Hal Eden)
- 3D environments (EDC + Jun/Smalltalk substrate) (Eric Scharff, Tomo Oda)
- Virtual Reality → collaboration with the CU “bp Center for Visualization” and their immersive environments supported by their “CAVE virtual reality environments”.

Step 4: explore new conceptual frameworks (we will use scenarios to identify "small and discrete clear win approaches". these become "boundary objects", "intermediate abstractions", and demonstrations of ideas that drive the project)


- context-awareness of computational environments which will extract the necessary information from the environment to support personalization and user modeling; a general background for this work is provided by: (a) Dey, A. K., Salber, D., & Abowd, G. D. (2001) “A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications,” Human-Computer Interaction, 16,(to appear); and (b): Fischer, G. (2001) “Articulating the Task at Hand and Making Information Relevant to It,” Human-Computer Interaction, 16,(to appear).

- research into prompting systems (Stefan Carmien and Jim Rebman).

Step 5: Develop a Kiosk in the Coleman Showcase Lab in the Discovery Learning Center (DLC) — we will focus on a design environment (with the bus stop as a product of that process) and the need for support of design processes that integrate technology into the world; the kiosk will allow us to conduct participatory studies with specific disabled communities

Step 6: develop and install prototypes in the “real world” (for example: in collaboration with CommArts; see Appendix 4)
Step 7: Scale up and demonstrate the sustainability of the approach (by using the experiences gained from the prototypes and with the inclusion of more mature technologies)

Challenges

This project creates numerous interesting and exciting challenges in social and technological areas and particularly in the integration of a socio-technical system. For illustration, we will mention just one example in the social and technological domain.

A Social Challenge: Changing Mindset and Cultures

Mobility is one of the most fundamental concepts of human existence and it is related to deeply held human beliefs and behaviors. As we know from experience: even major traffic jams will not be enough that people are willing to give up their private cars. It remains an open question whether individuals, groups and eventually cultures may find it at some point in the future “fashionable, enjoyable, and cool” to take a bus or a train (e.g., because a student finds out that all her/his buddies ride the bus. While such changes are not easy to achieve, they are also not impossible. After all: twenty years ago, most people and store owners resisted strongly cars being banned from downtown areas — and today, in Boulder and in many European cities the pedestrian areas have become the greatest attraction (the downtown mall in Boulder was designed by CommArts; see Appendix 4). We also believe that sometimes simple changes can have a big impact (e.g., being able to transport bikes with buses in Boulder) — and we need many more creative ideas that people do not only use public transportation because they have to, but because they want to.

A Technical Challenge: Exploiting the Power of Computation

A simple example-to-think-with for personalization and context-awareness is provided by the service by .com companies (e.g., such as MapQuest; see Figure 2) to provide people with individualized, personalized directions (a service which in principle can not be provided by print technologies).

While we believe that this simple example provides a good starting point, numerous extensions came immediately to mind:

- these maps currently provided are just for cars (e.g., no information is provided for bikes, walking, linkage to a public transportation system);
- providing the context, e.g., articulating the starting and the destination address is simple in some cases (when street

Figure 4: A Personalized Map
addresses are known), but can be far from trivial in other cases (e.g., specifying “non-standard” locations); to do so is complicated in many cases even for computer-literate people — and potentially impossible for cognitively disabled persons;

- if map is displayed on a PDA-like device, one can add a “you are here” marker to it (dynamical updates).