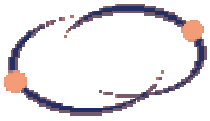
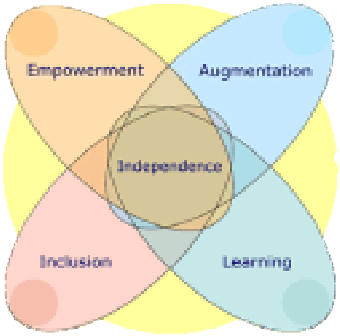


CLever: Building Cognitive Levers to help people help themselves—An L^{3}D Project funded by the Coleman Family Foundation



"Mobility for All" — A Socio-Technical Design of Human-Centered Public Transportation Systems"

CLever Research Project Team and Collaborators

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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); see also Appendix 5 "Palmtop Prompting System from AbleLink".

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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 document ed 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.*

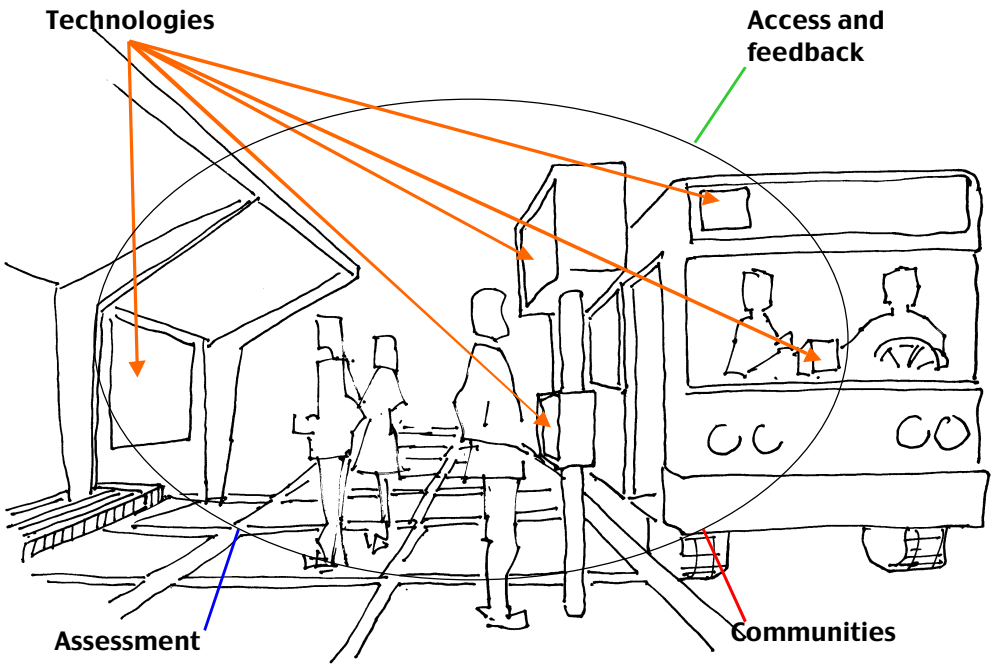

Figure 1: Human-Centered Public Transportation Systems — Envisioning an Intelligent Bus Stop

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 (for details see Appendix 4).
- **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); for details see Appendix 5).
- **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^3D 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 digitial 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)

- **personalization and user modeling** (to account for that people with disability represent a "universe of one"); we will build on a collaboration with BEA Boulder and their Weblogic substrate (Andy Gorman); a general background for this work is provided by: *Fischer, G. (2001) "User Modeling in Human-Computer Interaction," User Modeling and User-Adapted Interaction, Dordrecht, The Netherlands: Kluwer Academic Publishers, (to appear).*
- **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); see also Appendix 5 "Palmtop Prompting System from AbleLink".

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 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).

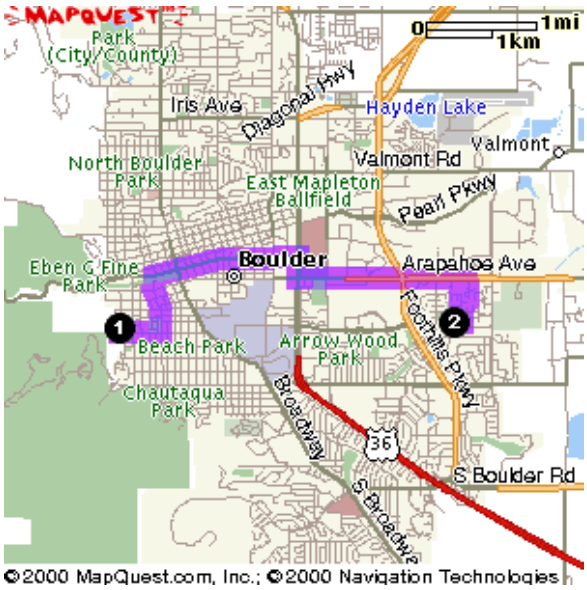

Figure 2: A Personalized Map

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

3. these maps currently provided are just for cars (e.g., no information is provided for bikes, walking, linkage to a public transportation system);
4. providing the *context*, e.g., articulating the starting and the destination address is simple in some cases (when street addresses are known), but can be far from trivial in other cases (e.g., specifing "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).

Appendix 1: "How Things Are" — Interview with Jim Rebman (Blind Person)

question: how you cope with public transportation systems in Boulder

This one is fairly easy as Boulder is generally fairly consistently laid out and most of the places I want to go are within reasonable proximity to bus routes. When I first came here I had to learn the rotation of streets and the system of addresses. I did this with the assistance of a human guide who had experience teaching blind people in orientation and mobility (O&M). I eventually learned the places where buses stopped and what routes ran where, and what times they ran -- mostly through the experience of riding them and taking mental notes along the way. I am afraid that most of the techniques I used will not work for a cognitively impaired individual as a lot of memorization and paying close attention to the environment were involved. A street guide or bus route guide will most likely not be too useful unless the information can be represented in some way other than words, lists, or complicated diagrams.

question: how you cope with public transportation systems in other cities

This really depends on how well the public transportation system works in a particular city. Since I am usually not very familiar with most of the cities that I tend to visit, I generally opt for a cab or similar arrangement. If it becomes really necessary to use the public transportation system and I can't find anybody to give me advice or assistance, I will generally call the transportation provider in the area and try to get as much information as possible. Often times though, there are helpful employees that will assist and give more information. In some big cities it is almost always possible to encounter blind people travelling on public transportation and usually we are more than happy to help each other out (another interesting aspect to the concept of community building). I was able to travel from my parent's house in the Virginia suburbs into Washington DC and back several times to attend a workshop on grant writing though I had never done this before and really had no idea of what to do -- I just called the metro authority and they gave me all the information I needed. I will say that to do this takes a lot of preparation, and I had some of the best O&M instruction available, yet it is still often a quite daunting experience. In most large and unfamiliar cities I will usually find another way to get around especially in the short term.

question: what are the major problems you encounter?

Mostly it is a question of getting information and in a form in which I can use it conveniently and effectively. Many public transportation providers now have their routes and schedules, etc. online on their web sites, but it is usually in a format that is not accessible with a screen reader. I actually tried to work with RTD on this long before their web site went public, but they never followed through and as a result, their site is not very usable to blind people.

The other big problem is what I would describe as learning the subtleties of the locale through experience. For instance, where are the bus stop signs and how do you differentiate them from other traffic signs (this is usually quite easy in the RTD system, but it took an experienced teacher to clue me into that fact) (note the necessity of human intervention). Sometimes, and this can't be overlooked, there are problems with bus drivers who, for whatever reason, don't like disabled people on their buses and are not very helpful and even sometimes downright hostile. Perhaps this stems from the fact that they have to "do more work" with a disabled passenger like securing a wheelchair, calling out stops for a blind person, etc.. This is not as uncommon as you would think. Other minor problems may include things like knowing where and how to pay your fare, if you are getting on the right bus or train, etc. For somebody like myself, I can always ask the driver what route he is (most of them will announce it when they see a blind person at the stop), but for somebody who has limited language and/or assertiveness skills, this won't work. Also at some very busy bus stops where multiple buses line up and leave quickly, it can be difficult to get to the right one before it leaves. Again, sometimes drivers will help out and flag down another bus if the one you are at is not the one you want. Some blind people I know carry cardboard signs with the route numbers printed on them in large type so the drivers can see them from a distance, and I know this also works well for deaf/blind individuals and others I have met with traumatic brain injuries who have severe short-term memory and strategic planning deficiencies.

question: do you have a vision of the public transportation system of the future which would make the system much more useful and usable to you!

Yes, I have been thinking about these problems ever since I lost my sight. Back in '92 or '93 I submitted an SBIR proposal for a GPS navigation system for blind travelers (with some modifications could be useful for a wide range of disabilities). I partnered with another blind guy and a Lt. Commander in the US Coast Guard whose area of expertise was differential GPS systems. We didn't get funded, but were invited to testify before a congressional transportation and science and technology subcommittee.

Last year when I took the UI Design class, I revisited this as part of one of my assignments and I will attach a text file of what I turned in for that assignment -- it deals directly with a Personal GPS system to aid blind travelers. One of the key pieces that I didn't include in this write-up that was in my original SBIR proposal was the concept of tying an emergency information base to the system so that people could get help anywhere anytime and also so that city emergency services could upload real-time data about fires, road and sidewalk repairs, and anything else that would possibly impede a traveler, to the system so that the routing software could redirect the traveler around the trouble spot. It is sketchy and there are a lot more details to go into this, and also this is only one aspect of the system. Other things might include intelligent kiosks, information servers on buses and trains themselves, and accessible signage (there are a couple of companies developing technologies for talking signs).

question: which concerns to you have about these developments (e.g., privacy issues)?

I don't think we want to get into technologies whereby the bus stop identifies the person through visual, RF, IR, or whatever kind of sensors. Here are my reasons.

- There are already some spooky government agencies that are using these technologies in airports. They are quite sophisticated and can evn identify people who have changed their appearance either through temporary means (growing or shaving off a beard for example), or more permanent ways like radical plastic surgery. This is too Orwellian and the potential for official misuse/abuse is too high in return for little benefit (the person can identify themselves as necessary and should just be "pulling" information from the bus stop.) Other kinds of "push" data can come from the person if desired, but should be dealt with in a seperate GPS-based system as I briefly described in my report (an emergency beacon which can alert care givers, authorities, medical assistance, etc. and does not need to be an integral part of the bus stop).
- The cost/benefit ratio of this is very high and we most likely don't want the bus stop itself directing people around.
- Involving the individual promotes more independence and a sense of being in charge of one's own matters. The number of devices and things that a person has to rely upon and think about greatly increases the potential for problems should any part of the technology fail. We should aim to keep most of the technology with the individual so it can be personalized to their needs -- the interactive points (bus stops, kiosks, etc.) should interact intelligently through an agent and give the individual whatever he/she needs from that particular kind of device. The kiosk or bus stop should not be telling the individual what to do based on its assumptions or memory of what that person may have previously requested (I don't think it should be storing any kind of transaction data that can be directly linked to an individual -- general statistical data is fine).

Appendix 2: "How Things Could Be" — Scenario "Cognizant Bus Stop" (Stefan Carmien)

Task scenario

Megan decides that today would be a good day to visit her grandmother. She goes to her home-helper screen and puts her palm pilot into its little cradle. She pushes the picture of her grandmother, on the monitor attached to the PC, and then pushes the bus picture (rather than the phone or greeting card picture). Her helper beeps and shows a picture of her front yard when it's finished getting ready for her trip. Megan takes the palm pilot out of the cradle and putting on her coat and picking up her backpack leaves the house. She knows that she must go to the bus stop across the street because the picture on the palm pilot shows *that* bus stop and the voice prompt tells her to cross the street to get to it.

She crosses the street and as she reaches the bus stop she touches the bustop picture on the pilot. The pilot says "Good Megan, now let's make sure this is the right bus stop! Please stand in the green square and hold me out towards the side that is red." Megan walks into the bus shelter and asks the person standing on the painted square to please move, as she needs to 'talk to the bus.' The man reading his paper looks at her and sees the brightly colored palm device in her hand and moves to the left, saying "Sorry, I didn't notice that I was standing on the *info square*."

Megan stands in the square and holds the palm pilot towards the side of the square painted red. In a few seconds the screen on her device shows a swirly pattern the reassures Megan that they are 'talking' about what she wants to do and what is the best plan. The swirly pattern goes away and Megan looks at the screen.

At this point there are two possible scenarios 'a' and 'b' that follow:

> **Scenario 'a' – all is OK:** Megan then sees the swirly pattern has changed to a series of progressively larger dots (the Isaac duration indicator – see the Isaac project), and a voice says "Megan, this is the right bus stop and the bus you want will arrive in five minutes" Megan waits patiently for her bus occasionally looking at the changing dot pattern on her pilot, and, when a bus pulls up, looking at her pilot and still seeing the changing dots, continuing to wait patiently. Several times the palm's display changes briefly to the swirly pattern but quickly returns to the dots. Just as the last dot turns almost completely white a bus pulls up and Megan walks up the steps. Megan's palm briefly goes swirly and the bus driver looks at a LED display located above the entrance door. The driver says "Going to Riverside, mam? This is the right bus." Megan goes all the way in and sits in the seat behind and to the right of the driver. The bus pulls out…….
>
> **Scenario 'b' – Megan is late:** Megan then sees the swirly pattern has changed to a big question mark. She pushes the screen over the image and hears "Megan, the bus you want has already left, please wait here for a minute." After a brief wait the screen shows a picture of BJ, her assistive living councilor, and she hers her machine say "Megan, please wait here – BJ says he will come and help you, remember if you need more help, stand in the *info square* and push the help picture. Remember – stay right here." In five minutes BJ arrives from the assisted living center and takes her in his car to her grandmothers house.

Technical Details

Megan's home is equipped with a visions-like system that synchronizes with her palm device, which has a color screen, 8 Mb memory and a wave file player. The Visions-like system and the palm device share an application that, when she selects a task for the PC system, uploads the images, wave files and task step sequences in the form of a database. This database application logs actions selected with timestamps for both later analysis and intervention when the user becomes stuck.

Megan follows the instructions to get to the bus stop and when she goes into the *info square* she is putting her palm pilot into a position where it can receive messages from an Ir broadcasting network router, with a range of one meter at 30º. The transceiver sends a one to three kilobyte

formatted string that her palm application parses to get the information she needs, and while the palm device is receiving the Ir modulated information it displays a 'recieving data' icon. The bus stop broadcasts the updated information every 3 seconds, and the communication is bi-directional so that the system in the bus stop knows who has received the broadcast and when.

When the broadcast is successfully received, the kiosk PC transmits to a server the location and identity of the PDA, this can be matched against the trip script that was registered with the server when it was hot-synched to the palm (and thus became active). This log allows the caretaker to be informed of problems, not unlike matching an airplanes actual path against a filed flight plan. (note: I am very aware of the privacy issues that this potentially raises, and would be interested in having conversations with users and caretakers about this)

The Ir transceiver is connected to a router that is in turn networked to a small PC with a wireless modem located (except for the antenna) in a sealed, weather & vandal proof box in the ceiling of the bus stop. The PC, router and modem are powered by batteries, which are kept charged by a solar panel on the roof, not unlike emergency roadside phones on highways. The PC communicates with a server at a RTD site that puts together information from schedules, GPS devices on individual busses and weather data to update the PC's in multiple bus stops in the city, each PC being feed the data it needs on a ongoing basis.

One possible additional function that this service could provide is a LCD display of the information that is gathered by the PC about the bus system state – It could display the scheduled bus arrivals and actual times till the next arrival, not unlike the displays at an airport. The principle is delivering the information in the most appropriate form to the user.

The bus is also equipped with an IR router and as Megan goes up the steps it polls her PDA for her trip-script and the intermediate goal of her next bus stop. The bus's system then displays the relevant information for the driver, which may include her next bus stop, her ultimate street destination, and some information about her special needs (i.e. blind, cognitively handicapped, Alzheimer's etc.). This also has privacy issues; perhaps the information could be displayed for the driver in a more private or coded fashion.

In the case of the ***panic button***, the PC, via wireless connectivity, sends a message to a caretaker center, like a 911 center, that receives a message identifying a lost (or about to be lost) person and where they are, and autodials the appropriate caretaker with this data, going from caretaker to caretaker till a touchtone acknowledgement is entered, at which point a message is sent back to the PC at the bus stop with the message that Megan received.

All the technology involved in the above scenario currently exists and every part of the system has been implemented for other uses. Obviously this is only a first pass at implementing a 'smart' bus stop. Much of the task was based on my own projection of what a cognitively disabled person wants and needs. **The technology is relatively easy- what will be difficult is to create a design that delivers the *right* information in the *right* form and at the *right* time.**

Research needs to be done on prompting systems and interviewing and observing real people with these specific needs. Further, this only describes one part of an (at least) three-part system – the configured tool; left to describe are the initial setup and configuration setup and the ongoing maintenance and creating new scripts interfaces and functionality. My anti-motto for this project is that 75% of all of these systems are rotting in a closet because of lack of good design and orientation; this one must not join them.

Interestingly enough, the more I think of this project the more it looks like I am designing a tool to make a prompting systems rather than a prompting system alone. This may be one part of our special L^3D approach to this design problem.

Who is Megan?

The target population for this device would be cognitively disabled individuals. From one of Anja's handouts this would be 'Trainable Mentally Handicapped' IQ 55-72 and the upper range of 'Severely Mentally Handicapped" IQ >55. Rather than use diagnostic language it might be more to the point to discuss that the user target population cannot do:

- They cannot read
- They have significant memory issues
- They cannot use abstractions (i.e. symbols have no extensible meaning)
- Their language is very minimal

What they must be able to do:

- They work well with prompting techniques
- They are socialized enough to be out in commercial establishments without having/causing problems
- They have fine enough motor coordination to use a palm pilot sized touch pad (and perhaps the set of keys below).
- They are sufficiently capable to not lose or damage a palm pilot device

For this scenario we also assume a caretaker who has programmed the palm device for Megan's trip. These users need an intuitive interface that is scaled to their level of skills with computers for creating and changing the trip prompting scripts. They will be assumed to be able to compose a letter on a word processor but not much more.

NOTE: Leo Burd contributed clarifying questions, Shin'ichi Konomi sparked the original idea and suggested the 'waypoint' function, Rogerio A. dePaula suggested the community extensions (the screen that shows the state if the bus system for 'ordinary' people), Faye Byrd looked at it from a caretakers perspective (and pointed out where Megan would sit and what the panic button should say) and Anja Kintsch reminded me to let the user know what was going on.

Appendix 3: What is out there — Some External Links

Shinichi Konomi: A bus location system using smart phones (Kyoto, Japan) — Kyoto Municipal Transportation Bureau and ASTEM RI (a research institute funded by the city) started a bus location service called Poke-Loke (Pocket Bus Location System) in August, 2000. People can use various types of popular smart phones (including iMode, EZWeb, J-Sky, H"LINK) or personal computers to display information about buses that are currently approaching to a specified bus stop. Users need to select a bus stop and a bus number in order to display information. Location information is updated every minute. They may reload the page to obtain up-to-date information.

Jim Rebman — Intelligent Transportation Systems of America web page and mission statement at: http://www.itsa.org/whatitsa.html → Then go to the Talking Signs homepage at: http://www.talkingsigns.com and read the "technical details" link and the "How talking signs work" link. extrapolate the concepts to the cognitively-impaired community, and you can see the incredible potential.

Stefan Carmien — The Isaac project: http://www.certec.lth.se/english/Isaac/ — Clock'o'clock (includes applets demonstrating various time representations): http://www.certec.lth.se/english/clock/

RTD Denver (see http://www.rtd-denver.com/) — provides a number of innovatives services such as:

- RTD Trip Planner: http://www.rtd-denver.com/cgi-files/webstar.cgi
- Wireless: http://www.rtd-denver.com/Wireless/Palm/index.html — "You can get wireless access to our Bus Locator information with our free Web Clipping Application / Palm Query Application (PQA) for the new Palm VII™. Palm VII™ users simply download and install RTD.pqa"

GPS Systems — Big Apple's Buildings Block Bus-Tracking Satellites → Here is an excerpt from a web site: *"Imagine standing at a bus stop and it [is] telling you when the next bus is coming. Right now, unless you can see a bus it's total uncertainty."* -- Beverly Dolinsky, director of the Citizens Advisory Committee to New York City Transit (http://www.space.com/businesstechnology/technology/nyc_mta_gps_000317.html)

Jim Rebman — I found this product which we should look into for developing a prototype of the intelligent bus stop. It looks very flexible supports many platforms and uses the standard OBEX protocol. This device could potentially be used within a house for uploading a person's personal prompting sequences to their hand-held. In fact, with its standard ethernet connectivity, the potential for remote administration is also very attractive. One could even take this whole concept further and dispense with the stationary, in-house prompting system in favor of a full-time, portable unit instead -- one device for the person to learn, easily maintained (or simply replaced), easily upgradeable as new technology becomes available without having to trash a large investment... many more benefits... and at $695, I think it is pretty affordable. I would love to get my hands on this and see what it can do!
http://www.clarinetsys.com/site/products-page/EthIR-STAR/EthIR-STAR.htm

Appendix 4: Design Projects of CommArts, Inc. in Urban Transit

CommArts, Inc. has designed a number of improvements to the basic fabric of urban transit. In Boulder, Colorado, CommArts has developed a design strategy branded as "Go Boulder" to humanize, add warmth, color and meaning to a number of popular bus lines. Graphic design programs coordinated with unique bus route names (the “Hop’, “Skip”, “Jump”, Leap”, and “Bound”) that speak to the routes, regions and reasons for each service area have been used to build a recognizable identity for the RTD system that is generally more appealing and fun to use. Busses are readily recognizable as they travel around the city, and riders in the system typically know more about where the busses go because they have seen them around town. Typical RTD busses tend all to look the same, making it difficult for users to know and remember where the various routes go. Go Boulder’s busses make it possible for bus riders to identify personally with “their bus”, building ridership in the whole system.

Go Boulder’s bus system has the added advantage of serving visually disabled riders better than a standard RTD system can. Each of the different busses in the system have radically different color schemes associated with them, making it easy to recognize them at a distance, easy to differentiate them at transfer stops, and generally easier for people to identify them with reduced visual capability.

CommArts has also designed a number of urban streetscapes that include transit infrastructures. In these projects, CommArts has made an effort to humanize the places where people wait for their busses by providing ample benches and shelter from the elements in a design vocabulary consistent with the shelter’s surroundings. CommArts has found that in situations where riders cannot be helped to identify with their busses directly, street signage and lights can build an identity for the route on which the bus runs. By integrating bus shelters into a broader urban identity program, transit ridership can be made more intentional, deliberate and efficient. Public transit is made a feature of the urban fabric, rather than being relegated by appearance to second class status.

In contrast to the above, there is a class of "hard" problems with public transit that result from infrastructural issues within the urban fabric in which our transit systems operate. Response time, for example, is inadequate for many potential riders who will not wait the time it takes for a bus to arrive. Additionally, suburban sprawl— the dominant urban fabric of most American cities— creates distribution networks fundamentally incompatible with public transportation systems. (Public transportation favors ring or grid topologies, where sprawl favors dendritic ones.) These "hard" problems may respond either to careful urban redevelopment, or to alternative transit systems- in either case requiring significant and costly community effort. They are largely outside the scope of this document.

The final class of problems relates to the quality and quantity of information available to riders while they plan a trip, wait for their ride, or while they are in transit. These problems are in many ways a more granular version of the "soft" problems identified above. And while these problems are problems for any and all transit riders, there are special instances of each for riders with physical and cognitive disability that deserve more detailed attention and analysis. It is this class of problems that we believe will most effectively yield to technological intervention of the sort under investigation through the Coleman Grant to the University of Colorado, and particularly to the work underway in the Center for Lifelong Learning.

All of these transit problems seem to have a few simple problems at their root. Riders need to know how their transit system works, how to use it, and they need status information as they use it. In addition, riders want to feel comfortable and to be treated with as much humanity as possible while they are using the system. The simpler and more universal the answers to these root problems are, the better and more efficient the transit system will be.

Specific informational problems may yield to digital mediation of some kind. Granularity can be added to bus schedule information by letting bus shelters "know" and communicate where all the busses on their routes are any given moment. Bus shelters can provide proposed routing information to riders ("How do I get from point Here to where I want to go, and how long will it take?") Communication between driver and rider can be facilitated by letting waiting riders speak to a driver en-route. But it is essential that the system work in the widest range of situations and for the widest possible range of users.

An intelligent transit infrastructure must include careful consideration of all aspects of the rider experience without the exclusion of any potential user. This likely would include targeted customization of transit information, possibly delivered to PDA's or some other personalized display. It also depends on careful design of the complete rider experience, and on a careful integration of both the physical and the virtual, the passive and the active. We believe that the best and most universally effective solutions to the problems of contemporary public transit will of necessity speak both to humanization of the physical infrastructure, and to the timely and targeted application of a new digital layer of information that adds universality to the system, and peace of mind to its users.

Appendix 5: Dan Davies — Research related to Palmtop Prompting System from AbleLink

Daniel K. Davies, President, dan@assess.net, AbleLink Technologies, Inc.

After visiting the Clever Project website recently, I ran across Stephan Carmein,s thesis proposal dated 1/23/01 titled „A Prompting System for the Cognitively Disabled" and thought it would be good to fill you in on some of our efforts in this area. Stephan contacted us late last fall for some information on our research and development efforts related to using technology for individuals with cognitive disabilities, some of which he referenced in his thesis proposal. Apparently, one of our projects was overlooked in his research and I thought I,d fill you in on some things that may help avoid „reinventing the wheel" regarding research and development efforts that have been undertaken previously.

The U.S. Dept of Education has been funding our Visual Assistant project (http://www.ablelinktech.com/) Click on Voyager, and then Visual Assistant) for two 1/2 years now and with this project we have successfully completed research and development of a Palmtop PC application that provides self-directed visual and audio prompts to help individuals with cognitive disabilities independently perform vocational and independent living tasks. Our system, Visual Assistant(TM) (Patent Pending), will be commercially released this summer, and is based on our Visual ImPact system (formerly PictureCoach) which provides picture, audio, and video based-prompts on a desktop computer to help individuals perform daily living tasks and thus live more independently. In fact, back in 1996 after we implemented our PictureCoach system for Stacy Baesman, Bill and Nancy Baesman,s daughter, during one of our previous Dept of Education research projects, the Baesman,s were so impressed with its impact on Stacy, they began marketing the Visions system which is based on our **PictureCoach system**.

Our Visual Assistant projects have been funded by the National Institute on Disability and Rehabilitation Research, the first project beginning in 1998 (http://www.ed.gov/offices/OERI/SBIR/ph198t07.html#assist) and completed in March 1999. That project was followed by a two-year project (http://www.ed.gov/offices/OERI/SBIR/FY99/phase2/phii99ablelink.html) which began in 1999 and is ongoing. This project has provided us the opportunity to fully research and develop the system and prepare it for commercial release. Along with Dr. Michael Wehmeyer of the University of Kansas, we currently have a research article to be published in Education and Training on Mental Retardation and Developmental Disabilities entitled, „Enhancing Independent Task Performance for Individuals with Mental Retardation Through Use of a Handheld Self-Directed Visual and Audio Prompting System."

Given the fact that Stephan,s thesis proposal appears to address very similar work, I thought it would be useful to let you know of our efforts. There certainly are many important extensions of our research that are needed, as well as new ideas altogether that make the options for new research almost limitless. For example, it may be beneficial for Stephan to consider focusing his efforts on a study addressing the impact of such a system for improving independence and quality of life for individuals with cognitive disabilities, using our existing Visual Assistant system. This would effectively allow a contribution of new research to the field. We would be happy to discuss such an opportunity if there is interest. However, that too may replicate other work as there currently is a Doctoral student at the University of Kansas that has been working with our Visual Assistant system during the last year that has proposed a dissertation topic based upon application of our system to individuals with cognitive disabilities. But even so, we would be happy to discuss alternative efforts that could build on the research basis that exists in this area if Stephan or anyone else is interested.

I see from your „Who,s Who" section on your website that you interested in external collaborations. I,d welcome the opportunity to hear more about your personal goals and objectives for your project and to investigate opportunities for collaboration between your project and our organization.

Best wishes regarding your future efforts to improve the quality of life for individuals with cognitive disabilities,