# Online Enlightenment:
# A Phidget Notification System for Online Status

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### ABSTRACT

This paper describes a physical device that presents online presence information in a semi-public space. The device uses a map metaphor to represent a set of connected labs, showing online instant messenger status for members of the community. Device users can combine information from the device with information from the physical environment to identify unfamiliar lab members, determine human-to-human interaction strategies, and plan meetings.

The paper reports on design decisions that were considered in creating the device, supplying rationale for decisions that were made. In particular, we focus on how people integrate physical information from the world and virtual information from this (and similar) devices in the environment, reflecting on ways in which this type of device can improve communication and enhance community. We describe four envisioned usage scenarios for the device, with early feedback from people who work in the space and whose information is displayed on the device.

### Author Keywords

Phidgets, notification systems, interruption, reaction, comprehension, human computer interaction

### INTRODUCTION

Instant messaging has shifted from a fun tool for planning social events to an essential work tool for coordinating project deadlines, and planning meetings. In response, the research community has been investigating desktop tools helpful to the business world. (See [13] for a good overview and summary.) However, our work seeks to move off the desktop, investigating how tools integrated in the environment can help not only individuals, but entire communities become more productive.

Starting from this base, the goal of this project was to create a phidgets-based notification system that would alert users in the HCI Lab which of their lab partners were available online currently, without having to walk around the lab and look. Phidgets, the physical widgets developed at the University of Calgary, are tangible interface elements used in creating real-world interfaces [1]. Notification systems are interfaces used in dual-task situations, where interruption, reaction, and comprehension are the critical parameters essential to consider in design [3]. These critical parameters guided decisions about goals for individuals at every stage of design, and helped to influence decisions for the community as a whole. In this work, critical parameter values ranging from 0 to 1 reflect the importance a user places on each parameter.

We were inspired by the work of Susannah McPhail (Tawse), a member of the phidgets group at Calgary. Her work on Buddy Bugs, an IM display tool, uses a "bugs-on-a-leaf" metaphor, where online buddies are represented by ceramic bugs [11]. We saw this as an off-the-desktop extension to typical IM tools, and we sought to take the idea to the next level of a community support tool.

There were a few constraints on what could be done which had to be taken into account at the beginning of the process. The first was a time factor, since the project had to be completed by the end of the semester. Secondly, the project had to utilize phidgets, as stipulated by the professor. Finally, the project had to be small enough in scale to be programmed and built by the three people in the class in the time allowed. Cost was desired to be minimal.

We used the general HCI approach and vocabulary found in [5] in designing our phidget interface: creating a root concept and problem statement, engaging in activity design, performing information and interaction design, prototyping, and evaluation. In addition, we employed (or considered) other design techniques, including participatory negotiation [4], ubiquitous computing evaluation areas (UEAs) [6], and the peripheral display toolkit [2]. This paper provides an overview of the general design process and decisions; for a full critical analysis of the effectiveness of the different design approaches we employed, look at [7].

The root concept required a centrally-located display of current online status of users in the lab, while ensuring easy reaction to this information and minimal diversion from users' primary tasks. Minimizing attention diversion is important because there are many users in the HCI lab that would be annoyed if the notification system constantly interrupted their normal tasks. We wanted those normal users to be able to go about work, but when information was needed, the notification system could provide it. By making the information easy to understand, the time spent interfacing with the system is minimal, allowing users to do their normal tasks instead. The system was built to promote communication within the lab, since many members are dependant on others for their work. By promoting communication, the efficiency of the lab would be subsequently increased.

In planning the project, Manveer Heir, Harish Hoon, and Goldie Terrell discussed a number of topics in a seminar environment, led by Dr. McCrickard and his graduate students. The seminar emphasized ways of viewing and designing our project that may not have normally been explored and served to provide a structured process to design and create the phidgets system, while having the flexibility to allow for debate and brainstorming.

The seminar went through a number of ways to approach the problem that were all used in some form. First came the use of scenario-based design and claims to analyze interruption, reaction, and comprehension (IRC), the three basic elements important to a notification system. Once claims and the IRC were understood, the seminar began to place emphasis on the difference between the user's model (How they see the system as they use it) and the design model (How the designers see the model as they design it). Once these things were understood, claims were then written for the notification system and IRC triples were associated with each claim. For more complete definitions of scenarios and claims, see [5], and for more on IRC values see [3].

After IRCs were calculated, the design of the notification system was revisited from the point of view of problem scenarios and problem claims. These highlighted the problems with the current ways of finding lab personnel. By highlighting these problems, it allowed the notification system to be built so that it solved these issues. Then, activity scenarios and claims were completed, highlighting activities performed using the system and specifying the metaphor to be used. Next, information claims were completed, showing what information was given and the details of the system. All the information claims related to one or more activity claims which in turn related to one or more problem claims. This way, the design directly addressed all the problems that were discussed in the beginning.

## DESIGN DECISIONS

In considering our redesign, we first thought about how well the existing MSN Messenger tool would meet the needs of the lab community. Many of the lab users already use Messenger to communicate with friends and are generally happy with it, but in considering the root concept described previously, Messenger was not as successful an interface. In keeping track of multiple users, it proved to be very difficult to acquire and maintain knowledge of their presence (high I, low C) and the reaction that was forced with pop-ups and blinking windows was a bit too high as well (high R). For our root concept tasks, the IRC was (1, .75, .25).

For our redesign, we sought to lower the I and R values, and to raise the C value. We felt this would meet our community-related goals: allowing those that come to the lab to acquire and retain knowledge about lab users while opportunistically interacting with them in appropriate ways with minimal interruption to all concerned. As our targeted design model was (0, .6, 1), at each stage of design we sought out claims that helped us to achieve these levels.

The three phases design that we focused on in the seminar were the Problem, in which information is collected about the current method for accomplishing the goal and the users desires; the Activity, in which the overall metaphor and general features are developed; and the Information/ Interaction, in which the details are designed.

We mapped out our scenarios for the current system of communication in the lab. We developed three primary problem scenarios representing activities carried out by different stakeholders.

*Scenario 1: Dr. McCrickard*

Dr. McCrickard walks into the office and takes a seat at his desk. He needs to start working on a report for the CS department that is due before the end of the day. He checks his MSN list to make sure everyone thats supposed to be in the lab is present. He specifically wishes to get some information from Ali for the report he is creating. Ali's status is online but he's listed as 'away' and Dr. McCrickard has no clue when he'll be back since there's no information of when Ali went 'away'.

Dr. McCrickard starts working on his project and forgets about his lab for a while but he must keep checking his list to check whether his lab users are active and working at the times they are supposed to be. This works as a constant interruption from his primary task (writing the report) leading to Dr. McCrickard missing his deadline with the department. The head of the CS department is not impressed. Dr. McCrickard sighs and thinks to himself, "There has to be a better way to keep track of users in my lab!"

*Scenario 2: Lab Users*

Jason is working in the lab and finds that he needs some information. He asks Ali, who tells him that Christa would have the information. The easiest way to contact her is by IM when she is online. Jason checks his MSN buddy list to see if Christa is online. He has organized his buddy list with a category for lab people, so he doesn't have to search through all his buddies. She is not online.

Jason opens the Preferences window in MSN and selects the General tab. He clicks on "notify when contacts come online", closes the preferences window and sends the Buddy List to the tray so that it doesn't clog his desktop. Unfortunately, if the tone plays while he is out of the room, he won't hear it. The only way that he will know then that Christa is online is to call up the Buddy window periodically to check Christa's status.

Jason continues working at his computer, doing homework instead of the lab project. After a while, he goes into the other room to talk with Edwin for several minutes. He gets his lunch and goes back to work some more. The tone sounds and the popup window announces Justin is online. Wanting to talk to Justin also, he clicks the text in the popup box to open a conversation window with Justin.

He continues to work at his computer, sometimes going out of the lab for a few minutes. After two hours, he checks the Buddy list. Christa is online, so he opens his Buddy list, finds her name in the Lab People category, and opens a window to chat with her.

In the course of the conversation, he finds that she had been on for awhile. The tone must have sounded when he was out.

*Scenario 3: Visitors*

Dr. Aref, the Dean of Engineering, comes into the HCI lab to check on the status of things and see how the lab is running. Dr. McCrickard recently told Dr. Aref that the lab is prospering and that they are building good community in it.

Dr. Aref enters the lab and sees nothing but a few computers around the room, with some nerf guns and remote-controlled toys on the floor and posters on the wall. Besides a few candy wrappers, it is not clear that the lab is widely used. Unimpressed, Dr. Aref asks Dr. McCrickard why the HCI lab doesn't have any nifty, accessible displays, which would catch the interest of non-technical people and help practice what is preached in the lab.

**Problem Phase**

A participatory negotiation session [4], attended by students, research scientists, and faculty who use the lab, helped to set the priorities for claims from our scenarios. With the results from the session, we were able to clearly define our scope for this project in the given time frame for completion. We settled on tackling specific issues (claims) that received a high priority in the session. The claims are given here, along with their IRC values.

A) <u>Notification appears on computer screen</u> (1, 0.8, 0)
- + interruption is obvious, if working at the computer
- + reaction is easy since you are already at the computer
- + notification using text provides a lot of information
- + use of keyboard and mouse well-known
- - takes up screen space
- - must be at computer, or notification must be persistent

B) <u>Finding all the lab users using MSN</u> (1, 0.8, 0.1)
- + easy to get all the information you need at once
- + intuitive to respond if needed
- - requires access to a computer
- - becomes your primary task
- - in order to track the lab's status, we must keep checking the list
- - no history of information regarding the state of the user over a period of time
- - no information of how long the particular user has been in that state for

C) <u>Lack of a dynamic interactive representation of lab status</u> (-, -, 0.1)
- + decreases clutter that can interrupt people in the lab from their primary tasks
- + more desk and wall space can be dedicated to other (less dynamic but more information-rich) displays (like posters)
- + discourages outsides from entering lab
- - provides no sense of direction for a visitor
- - can lead to a bland and boring lab area
- - Visitors leave with no good understanding of personnel activity in the lab
- - does not highlight what HCI is about

*Goal:*

Our goal is to design a device that provides easy access to information regarding the availability of lab users while attracting and impressing visitors.

**Activity Phase**

Hence we proceeded to our design phase where our goal was to eliminate all or most of the cons for our problem claims while maintaining and adding to the pros. Activity claims, capturing the activities we see as most important to our stakeholders, are as follows:

A) <u>Find all lab users using a centrally located physical device</u> (0, 0.7, 0.3)
- + Easy to get all info needed at once
- + Moderately intuitive
- + Does not require access to a computer
- + Lets you continue your primary task
- + Can record history
- + Looks "Cool"
- - Takes up desk space
- - Less flexibility

- limited text display
- metaphors could get confusing

B) <u>Map based representation</u> (0, 0.5, 0.6)
+ Intuitive
+ Easy to match people in lab with representation in map
+ Easy for outsiders to understand matching
- History may be hard to display

C) <u>Caricatures and text to represent lab users</u> (0, 0.7, 0.7)
+ Easy to connect to people
+ Easy for visitors to identify occupants in multiple ways
+ Fun for Lab users to use
- Hard for non-dedicated machines
- Caricatures lessen privacy issues compared to photos

D) <u>LCD used for text information</u> (0, 0.4, 0.6)
+ Gives information that would be hard to communicate otherwise
+ Increases comprehension
+ Color/Lights draw the lab user's attention
- Displaying information may violate privacy
- Limited room for information on the LCD

E) <u>Historical data shows people's status</u> (0, 0, 0.6)
+ Gives all the information collected
- Very hard with phidgets

### Information/Interaction Phase

Just as the activity claims emerged from the problem claims, we sought out information and interaction claims that would best match our activity claims. We tried to eliminate the cons from our activity claims while the form and details of this physical device become more apparent. Certain key claims were:

A) <u>Person's light on for online, blinking for away, off for offline</u> (0.5, 0.7, 0.2)
+ easy to distinguish differences in lights
+ intuitive meaning, if you know its about MSN
- doesn't give reference to MSN
- blinking may be distracting (this functionality was later removed)

B) <u>Wall mounted display (vs. desk)</u> (0, 0.2, 0.7)
+ doesn't take up desk space
+ LCD shows when the user's status changed
+ Gives a decent amount of historical information
- calculations need to be done in program

C) <u>Pushbuttons for each person change LCD info</u> (-, -, 0.3)
+ don't have to wait for info
+ allows test of phidgets feedback (for learning more about phidgets)
- more complicated to program

D) <u>Push Buttons Include User Caricatures</u> (-, 0.5, -)
+ Easy to push
+ Easy to associate with matching user
+ Masks identities of users
- More space than typical button
- Not obvious that caricature is a button
- Wear shows which users are most popular

E) <u>Map of lab matching user desk positions physically</u> (-, 0.2, 0.6)
+ Assists in finding people users don't know
+ Assists users familiar with lab in finding people's info display
+ Can see groups of lab users with similar interests
+ Wall and door representations increase understanding even for non-lab users
- Can't alphabetically find names
- Violates privacy
- Lots of white space on maps

As you might have noticed, many cons for these claims are issues dealing with the complexity of actually programming the device rather than issues with physical design. Thus, the end user should not be negatively impacted by the design. Other cons should be accounted for in future implementations.

*Goal:*
Our goal is to implement a map based representation of the lab which is wall mounted and has lights to represent the online status of lab users and an LCD to display additional historical information about each user when required.

### Overview of System Prototype

We sought to include as many of the information and interaction claims as possible in the system prototype, to allow us to test them in the evaluation phase and validate or refute our claims. As described in the root concept, we chose to use MSN and phidgets as shown in Figure 1.

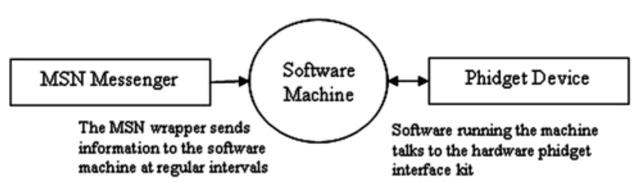


**Figure 1: high level system overview.**

### INFORMATION COLLECTION DETAILS

There are three objects that must be accessed to gather the information from MSN Messenger: *IMessenger*, *IMessengerContacts*, and *IMessengerContact*. *IMessenger* is the actual MSN Messenger Object. Within *IMessenger* is an aggregate called *MyContacts*, of type *IMessengerContacts*. *IMessengerContacts* stores all the contact list information as a whole. Within *IMessengerContac*t is data member called Item, which extracts the individual *IMessengerContact*. This object contains the information needed. See figure 2 and 3.

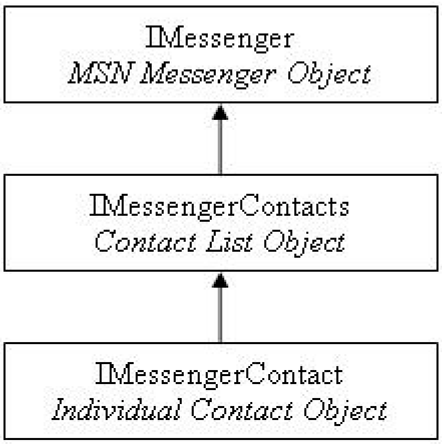


**Figure 2. Aggregate Hierarchy: *IMessengerContact* is a part of *IMessengerContacts*, which is a part of *IMessenger*.**

| IMessenger | IMessengerContacts |
|---|---|
| *MyContacts* **(IMessengerContacts)** | *Item* **(IMessengerContact)** |
| *MyFriendlyName* | *Count* |
| *MyPhoneNumber* | *IDsOfNames* |
| *MyProperty* | *TypeInfo* |
| *MyServiceId* | *TypeInfoCount* |
| *MyServiceName* | **IMessengerContact** |
| *MySigninName* | *Blocked* |
| *MyStatus* | *CanPage* |
| *ReceivedFileDirectory* | *FriendlyName* |
| *Services* | *PhoneNumber* |
| *UnreadEmailCount* | *Property* |
| *Window* | *SigninName* |
| | *Status* |

**Figure 3. Private Data**

Information collection from MSN Messenger was rather straightforward. A pointer to the *IMessenger* object was created. From that pointer, the *IMessengerContacts* pointer was accessed, containing the entire contact list. Within *IMessengerContacts* was a variable Item that took an index, much like an array. Each index number gave a different *IMessengerContact*. Once a pointer to the contact is found, all pertinent information about that contact can be gathered. The information gathered for use in this program was the current status and user name.

Once this information was gathered it was cross-referenced with a list of contacts that need to be updated for the phidgets to work. This list contained the e-mail address of each person on the phidgets board as well as a number to indicate which light to enable. The numbering system is pictured in Figure 4 for each button/light.

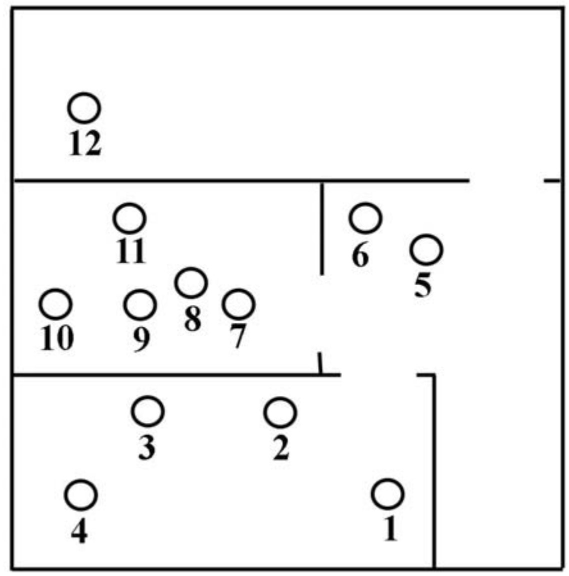


**Figure 4. Button Numbering Scheme**

If the contact was in the list and the status of the contact had changed from the status currently stored, the current time was reported in the array holding all the information to be accessed by the phidgets. Otherwise, the next contact was queried the same way. This was repeated until all contacts had been queried.

The only input came in a text file that contained the user names of the people that need to be kept track of using MSN Messenger. This way, a database could be created for each person, and their details could all be kept track of. To create the database, a simple structure was created. Within the object were four data members: the user name, current status, time stamp of last status change, and position which indicated which light on the phidgets system should be lit up. The phidgets program directly accessed this database to get all the necessary information and manipulate the lights and LCD correctly.

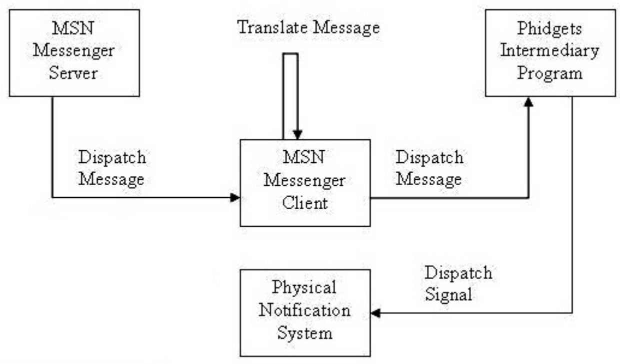


**Figure 5. Data Flow**

In the end, the data flow worked as in the diagram in Figure 5. Messages were dispatched from the main MSN server. Those messages were sent to the MSN Messenger client, and updated a user's contact list. The same messages were relayed to the phidgets intermediary software, which converted the message into a signal to send to the physical notification system. Some of the signals sent are "light on", "light off", and "display".

## PHIDGET PROGRAMMING

Building on the information collection from MSN Messenger, we needed to drive the device and build the software machine that would control our physical messaging system. Helpful documentation for this purpose is available at http://www.phidgetsusa.com.

We used a variety of phidget devices:

- 8 Digital Input / 8 Digital Output / 8 Analog Input Interface Kit
- Text LCD ( 2 Line 20 Characters/Line)
- 8 Digital Input / 8 Digital Output Interface Kit (came with the Text LCD)

While a wealth of documentation was available for programming the device in Visual Basic, for compatibility reasons we used C++. A mandatory install of the library files available on the website is required to program (phidgets.msi) and run phidgets.

Basic Functionality Required:

- Turn Light On/Off
- Check Button On/Off
- Display text on LCD

After these basic functions to run the phidget device were learnt, we proceeded to build the software machine.

Steps taken to use the device are shown in Figure 6.

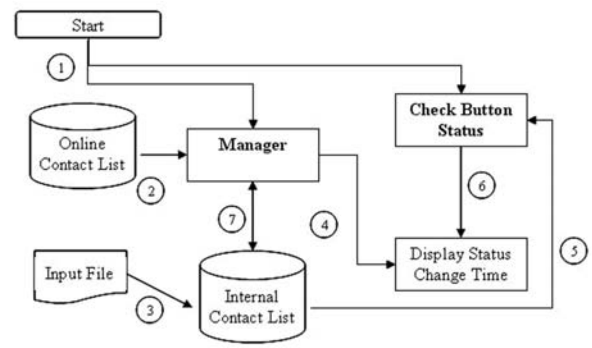


**Figure 6: Internal Working of the Phidgets Software Machine**

Manager

This function controls all the processes related to the software machine. For example, it checks the user's status and switches the lights on/off accordingly.

Check Button Status

This function continuously runs in the background to check whether a button is pressed.

*Processes Legend*

1. The program starts and creates two processes, one calls the manager function, the other calls Check Button Status
2. Every second the manager function polls MSN messenger's online database to check the status of contacts.
3. The program creates a data structure to store information of the contacts we need to keep track of. These contacts are determined from the input.txt file on the hard disk.
4. If a contact changes his/her status, the manager function will display their information on the LCD.
5. If a user's button is pressed, the function will retrieve information about the user from the internal data structure used to store contact information.
6. If a user's button is pressed, the function will make the LCD display that contact's status and information.

If the status of a user changes, the manager function changes the information locally stored for that contact. The manager also retrieves information to switch on/off the correct lights on the device.

## PHYSICAL MODEL DESCRIPTION

The model is constructed of wood, with the "floor" made of sheet metal covered with cloth to simulate carpet. The outside walls are held together with braces and corner screws. The inside walls are screwed through the sheet metal and/or glued to other walls with Liquid Nails Small Project Glue. The outside walls have a groove that the sheet metal and fabric fits into. The fabric is wrapped around the edges of the sheet metal and glued on the back side with the same glue. It is also glued near each LED. An extra piece of metal is glued on to hold the fabric as it extends though the hall doorway.

The buttons are SPST N.O. Momentary Pushbuttons (PB-224) purchased from All Electronics Corp. (www.allelectronics.com). N.O. means normally open, as opposed to N.C.- normally closed. If N.C. are used, the button registers as "on" when it is not pushed and "off" when it is. The buttons push through a one inch diameter hole drilled in the sheet metal and appropriate slashes in the fabric. The locking "ears" may need to be manually expanded because of interference from the cloth.

Standard 20-22 gauge insulated wires are crimped onto disconnects (available at auto parts or hardware stores) and attached to the terminals of the buttons. The wire ends are bare to be inserted into the input holes of the phidget boards. It does not matter which terminal goes to ground and which to a numbered input. The ground wires are put together with wire nuts to reduce the volume of wires into the ground terminals of the phidget boards. Ground wires are green and hot wires are red or yellow, depending upon which board they lead to.

The lights are green 2.1V, 30mA, 5mm LEDs purchased from Radio Shack. They are pushed through holes from the back of the sheet metal, being stopped by a collar at the base of the LED, and then glued in place with Liquid Nails Small Project Glue. They also go through holes in the fabric made with a leather punch. The short leg of the LED must be put to ground. Telephone wire is soldered onto the LED legs. The color scheme is the same as on the button wires.

The LCD is a phidget, with an attached 0/8/8 board. Its housing is cut from a plastic box that I had at home and painted with spray paint for plastics. (Other housings, called project boxes, may be purchased from Radio Shack.) The sheet metal is cut out under the box, except for ears, which are bent up to provide places to screw the box into. The LCD and attached board are machine-screwed to the box. The outside wall thickness is reduced under the box to allow space for the wire connections.

The other phidget board is an 8/8/8 board, machine-screwed to plastic pieces left over from cutting the housing box, which are then screwed to the outside wall under the sheet metal. Plastic is used to prevent unintended electrical connections on the board.

The caricatures are printed on plain paper, although cardstock is recommended to increase the stiffness. A layer of carpet tape (thicker than packaging tape) is used on the front to prevent wear. The green covers on the buttons were removed to provide a flat glue surface. 1" fender washers are glued to the button faces using Goop Marine Adhesive and Sealant. The caricatures are affixed to the washers with double sided tape.

The power source wire and USB wire are run through a cutout in the outside wall. They are held together with two zip ties, which act as a strain relief. (A strain relief keeps wires from being pulled out of a device.) A 1/8 inch panel board is screwed into a mortise in the wall edges. This closes the cutout so that the zip ties cannot be pulled out of the model.

The photos in the appendix help to clarify the construction.

## INITIAL USAGE REPORT

Initial usage reactions were collected via two means: initially through an unveiling at a session open to all lab users (both regular ones with desks in the lab as well as occasional ones who only dropped by the lab from time to time), and in an ongoing manner through comments of lab users and visitors.

All of the participants invited to the participatory negotiation session were also invited to the unveiling. Many participants had seen partially working versions of the system earlier; some had even observed and tried it, to the point that they understood much of the functionality. We started the session with a brief overview, followed by an explanation of how OE works, and concluding with a demo. The bulk of the time was left for an open discussion. Reactions were as follows:

- Many reactions involved increasing the power and functionality of OE, including AI-like processes to anticipate schedules, showing much more information, etc. Many of these suggestions had been considered and dismissed during design as too complex for many users to understand easily. We tried to guide discussion toward OE's perceived ability to meet its goals.
- There were no complaints about the interruptiveness of the final display, though some suggestions for augmentation (blinking lights, tickering messages) raised objections from people who thought they would be interrupted.
- Regular lab users seemed to think that they may begin to react appropriately when the display was present for an extended time, though some acknowledged that the display may just fade into the background, never really "seen" after an initial usage period. Similarly, comprehension seemed to be supported after an initial explanation period, but few dared to speculate on whether comprehension of lab member activities would be enhanced.
- No complaints emerged regarding the type of information shown, and nobody requested that their

information be removed from the display, reflecting that for this group privacy concerns are not a major issue.

As of the time of this paper, the phidgets system has been in use in the McBryde 104 LINK-UP Lab for about two weeks. Listed here are a few stories from its usage.

- One student came into the lab looking for one of the graduate students, all of whom are house in one of the sub-rooms (104A) in the lab. He noticed that all were online, but, upon pressing the buttons for each, saw that all had been offline for about 15 minutes. He concluded that they all had probably gone out together to class or lunch and decided to check back later rather than wait for them to return.
- Usage of MSN Messenger differs greatly from person to person. Some are almost always connected, not logging off from one site until they log on to another. Others had to be all but required to use it (perhaps fine for some companies but awkward for a research lab). However, regular users seemed to quickly realize whose display reliably reflected presence and whose did not.
- As with many ubiquitous displays, we felt compelled to hang a sign on OE, explaining how it functions. We view this as something of a failure; ideally, such a system should be self-explanatory.
- There were no reports of OE being overly interruptive, but only a few stories (see previously) of it prompting additional reaction or comprehension. As OE is integrated in the environment, we hope to collect more stories of its use.

We hope that these initial experiences provide a glimpse into the possibilities for this type of interface.

## CONCLUSIONS

This project used phidgets and compatible hardware in the creation of Online Enlightenment (OE), a semi-public ubiquitous system for monitoring online presence of lab members on MSN Messenger. In its current form, there are drawings of each person in the lab on buttons in a layout that mirrors the lab. Upon pushing a person's button, the person's name, online status, and time since the person's last MSN Messenger status change is displayed on an LCD screen at the top of the phidgets board. This gives information that is not available in the standard Messenger interface. Also, under each drawing is a green light that shows the current status: off for offline and on for online. The buttons are also labeled with the person's first name or nickname so that guests to the lab can identify the person that they are looking for.

Seemingly the most important lesson learned was to simplify! Initial ideas included many more types of phidgets: ones that spun around, made noise, moved pieces of plastic around, etc. But it was simple (but effective) design elements, like LEDs, the LCD display, and the familiar map metaphor, that proved to be most effective. We welcome but are cautious about new functionality that can be added, as we wish to keep focused the purpose of Online Enlightenment while meeting the goals of potential users.

## FUTURE WORK

The phidgets system is on display on the wall in the McBryde 104 LINK-UP Lab and it is expected to be used mainly by the regular lab inhabitants, but also by the many visitors, both regular and occasional. We plan to observe its usage over the next few months, collecting data on how well it meets our design model (particularly regarding our selected IRC parameters), our emphasized OEM parameters, and the metaphors we chose to employ.

Important to us is the effectiveness of the IRC parameters, both as they impact and help to measure individual desires and performance but also as they reflect the dynamics of the group as a whole. While the IRC values provided throughout this paper were only for individuals using OE, it will be important to our future work to consider how IRC can reflect the lab as a community.

Also of interest to us is the "space vs. place" dynamic that we anticipate will emerge as Online Enlightenment is used. Harrison and Dourish first formally introduced this dynamic with respect to objects and technologies located in physical and virtual places [9]. They sought to explore how it was a culturally rich place, not a physical space, that is often more valuable to capture in design. Others too have built upon this idea; Grudin, for example, sought to understand how individuals use multiple monitors to transform space into place to help meet their own goals [8]; and Lederer created a system that allowed remote collaborators to virtually position themselves in a space representation to help enhance place [10]. We find this "space vs. place" dynamic particularly relevant with respect to our map metaphor and our caricatures, and we seek to better understand how Online Enlightenment (in various forms) can help enrich our collaborative environment.

Given the time constraints under which the system was built, there are always other small changes that could be made—the remainder of this section is something of a laundry list of potential changes.

- As was mentioned earlier, extending the LED display beyond the binary on/off status may enhance comprehension with less interruption. Even a simple 3-way LED could differentiate online-away-offline status, increasing
- Under consideration is to build alternate interfaces (web-based, large screen, etc.) positioned elsewhere in the HCI space at Virginia Tech to display lab presence information, allowing users to check from elsewhere whether or not someone is in the lab and

when they last were. That way, they could talk to that person as necessary without wasting a trip to the lab. However, users may feel such public and/or online equivalents violate their privacy and threaten their well-being. We would also need to consider how the design models differ for each space.

- Another desired enhancement is to keep the daily online history of lab users so that people can keep track of who has been working in the lab and for how long. Use of other phidgets in the display is also a possibility, as they are developed and as they meet the information needs of the lab users.

For all of these proposed future changes, particularly those in this last laundry list, as we noted in the conclusions we want to be careful to focus our efforts on meeting the goals of the lab users, both individually as well as collectively.

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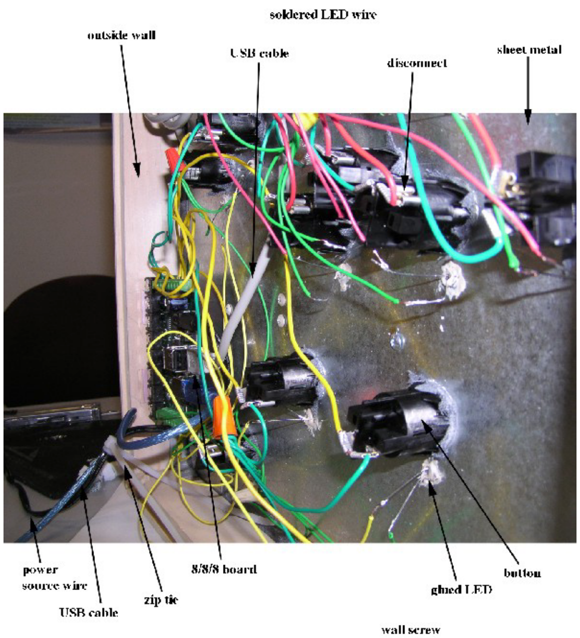
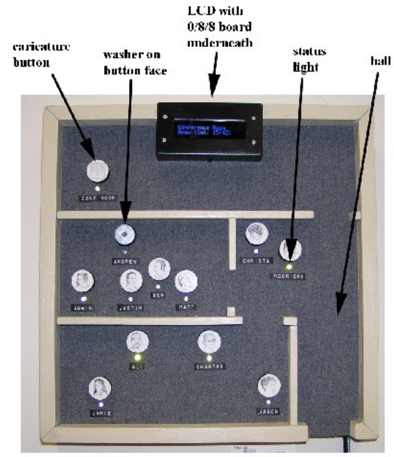
### REFERENCES

1. Greenberg, Saul, and Fitchett, Chester. Phidgets: Easy Development of Physical Interfaces through Physical Widgets. *Proceedings of the ACM Symposium on User Interface Software and Technology (UIST 2001)*, November 2001, pp. 209-218.
2. Matthews, Tara, Dey, Anind, Mankoff, Jen, Carter, Scott, Rattenbury, Tye. A Toolkit for Managing User Attention in Peripheral Displays. *Proceedings of the ACM Symposium on User Interface Software and Technology (UIST 2004),* November 2004, 247-256.
3. McCrickard, D. Scott, Chewar, C.M., Somervell, Jacob P., and Ndiwalana, Ali. A Model for Notification Systems Evaluation—Assessing User Goals for Multitasking Activity. *ACM Transactions on Computer-Human Interaction (TOCHI),* volume 10, number 4, December 2003, 312-338.
4. Ndiwalana, Ali, Kampanya, Nithiwat, McEwan, Ian, Chewar, C. M., McCrickard, D. Scott, and Pious, Kevin. A Tool for Participatory Negotiation: LINKing-UP Participatory Design and Design Knowledge Reuse. *Proceedings of the Eighth Biennial Participatory Design Conference (PDC '04),* volume 2, July 2004, 118-122.
5. Rosson, Mary Beth and Carroll, John M. *Usability Engineering: Scenario-Based Development of Human-Computer Interaction*. Morgan-Kaufman, San Francisco, USA, 2002.
6. Scholtz, Jean, and Consolvo, Sunny. Toward a Framework for Evaluating Ubiquitous Computing Applications. *IEEE Pervasive Computing*, volume 3, number 2, April-June 2004, pp. 82-88.
7. Terrell, Goldie B. A Critique of Design Approaches for Notification Systems. *Virginia Tech Department of Computer Science Technical Report TR-04-21*, December 2004.
8. Grudin, Jonathan. Partitioning Digital Worlds: Focal and Peripheral Awareness in Multiple Monitor Use. In *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2001)*, April 2001, pp. 458-465.
9. Harrison, Steve and Dourish, Paul. Re-Place-ing Space: The Roles of Place and Space in Collaborative Systems. In *Proceedings of the ACM Symposium on Computer Supported Cooperative Work (CSCW '96)*, November 1996.
10. Lederer, Scott and Heer, Jeffrey. All Together Now: Visualizing Local and Remote Actors of Localized Activity. In *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2004)*, April 2004, pp. 1107-1110.
11. McPhail, Susannah. Buddy Bugs: A Physical User Interface for Windows Instant Messaging. In *Proceedings of the Western Computer Graphics Conference (Skigraph '02)*, March 2002.
12. Neustaedter, Carman, Greenberg, Saul, and Carpendale, Sheelagh. IMVis: Instant Messenger Visualization. In *Proceedings of the ACM Symposium on Computer Supported Cooperative Work (CSCW '02)*, November 2002.
13. Tang, John and Begole, James "Bo". Beyond Instant Messaging. *ACM Queue,* volume 1, number 8, November 2003.

**APPENDIX**

This section contains photographs of the OE phidget notification system.




The dividers represent the walls in the lab and the cutout at the bottom represents the entry hall. The caricatures are spaced roughly on the position of the computers in the lab. Justin, Ben and Matt share a computer, as do Christa and McCricks. This provides three means of identifying a person: his image, his name, and his location.