# ICE: Interactive Campus Envoy

# Phase 3: System Prototype and Evaluation Plan

## Design Justification

Three approaches of the Interactive Campus Envoy (ICE) design were proposed in Part 2 of this project, including solutions designed for cell phone, augmented reality, and handheld personal digital assistant (PDA). Each solution includes a knowledge base of campus locations and events and allows the user to create an optimized route to a destination on campus.

The cell phone design proposed adding symbols to unnamed pathways along campus to help the user locate his position and to allow presentation of verbal directions using those pathways. This solution took advantage of the commonality of cell phones and people's familiarity with their use.

Our augmented reality design superimposed a highlighted route on the user's field of vision as she walked the campus. The user "followed the yellow brick road" and could focus on the environment while traveling. However the hardware is uncommon, expensive, and may be distracting.

The PDA's visual capabilities suggested a map-based solution, which offered more information and flexibility than the cell phone. It has more mature technology support and is less expensive than augmented reality.

We let our prospective users determine which model we would design and prototype for phase 3 and they chose the PDA-based solution.

The PDA-based interface is a GPS-equipped, map-based system with functionality similar to MapBlast, MapQuest, and the like. Although PDAs are currently not as widely used as cell phones, we are looking a couple of years down the road to the day when PDAs are more common and GPS is firmly entrenched in the mobile computing world. The PDA's interactive map capabilities offer flexibility beyond the verbal communication of the cell phone, and its point-and-click interface is familiar to anyone with experience using WIMP interfaces or handhelds.

### Narrowing the Choice

We made use of the design alternative poster from part 2 of this project to narrow our choice of prototypes. The poster was shown to 12 potential users, and we briefly

described the intent of the system and the operation of each design. We then asked them to fill out a subjective questionnaire in which they ranked the designs in order of preference, stated what they liked and disliked about each design, and asked which design they personally would use.

The handheld computer design was preferred slightly more than the augmented reality design and the cell phone design ranked last. 75% of the people said they would most likely use the design that they ranked first in the survey. One user who preferred the AR design said he would use the handheld instead saying, “I’d feel like a dork wearing the augmented reality mechanism.” Another user who preferred the AR design said he would use it to locate unknown places and use the handheld to locate known places. A user who preferred the cell phone design said she would not use any of the designs because she owned neither a cell phone nor a GPS enabled PDA and already knew the campus well. Overall, 46% users said they would use the handheld device, while 29% preferred the AR option and 17% preferred the cell phone.

Aspects of the handheld design that users liked were the usefulness and unobtrusiveness of the device. Many liked the visualization of the route and displaying their current location on the map. This coincides with results from our phase 1 survey showing most people preferred using a map to written or oral directions. Dislikes mentioned included the need to carry another device.

Characteristics of the cell phone design that users liked were its ubiquity and their comfort in using a cell phone. However, half of the users disliked the modification of the campus. Others mentioned that it was non-intuitive and time-consuming.

The easy to follow, “overlaid path” interface was what users stated they liked about the AR design, while 33% of those surveyed did not want to use a wearable computer, with two people referring to it as “dorky”.

Based on the data we gathered from our users, the PDA system was chosen as our system’s platform. Using the feedback from our users, we attempted to converge on a final design. Cell phones are more popular on campus now than PDAs, but PDAs are becoming more common and for those that do not want to carry multiple devices, PDA/cell phone combo devices are gaining in popularity. In an attempt to merge the ease of following an overlaid path on a PDA, we suggested having a database of pictures of all the intersections on campus. While following a route, as you approach an intersection, you can choose to view a picture on the PDA. The picture will have an overlaid arrow indicating which direction to turn. We suggested this idea to potential

users while showing them a paper mock-up of the system. The users either did not think intersections on campus were that “tricky” or thought the idea was “overkill”. We thought about providing text directions in addition to displaying a route on the map, but decided directions using unnamed paths would not be very helpful.

## Design Process

After selecting the handheld computer design, much time was spent refining it and considering alternative ways to perform its functions. The following are factors we considered while designing software for the PDA:

- The PDA has limited screen size and real estate is a primary concern. We limited the number of buttons and other features on the screen in order to make the map as large as possible.
- Since many PDAs don’t offer a keyboard, the user may need to use a stylus to enter text data, such as a destination. This can be time-consuming, so we added a shortcut by which the user could probe the map to obtain building names.
- The PDA display may be in color or black-and-white. Therefore, the appearance of the interface in both modes should be considered.
- Since a PDA display is small, the use of pop up menus require careful consideration, since they take over a large portion of the display and may block important screen contents.
- Using a stylus to interact with the map could cause the user’s hand to obstruct necessary information, so pop-up menus were designed to project upward from the selected point wherever possible.
- Several of our users felt we should add orientation to the map so that the direction in which the user was facing was always at the top of the screen. This technology doesn’t appear to be available. The user can turn the PDA in any direction as one would a map.

When we had an initial proposed design, we created a paper mockup with a variety of screens and had 5 potential users complete the following tasks:

- You are at the Student Center and need to go to the Graduate Living Center.

- You are at the Student Center. You and a friend in a wheelchair need to go to Bobby Dodd stadium. Create a route to it.
- You are at the Student Center. You need to go to a building that is near the basketball stadium. You forget its name, but will recognize it when you see it. Find the building. Once found, create a route to it.
- You are at the Student Center and want to find out John Stasko's office hours. Once found, you realize they start in 10 minutes. Create a route to his office.

A major goal of this test was to gauge which of the zooming methods participants preferred. We also wanted to understand the process a user goes through when trying to create a route. Feedback from these tests allowed us to improve the design of our system.

We decided the main interactions with the map would be accomplished by selecting a tool, which changes the operation of the stylus when it touches the map. These tool buttons are always visible and the selected tool is easily distinguished. This approach is easy to learn, although it may not be the fastest method. We decided to offer an alternative approach for advanced users. If the default tool is selected, you can use a set of gestures on the screen to perform the same actions provided by the tools. These gestures must be learned and recalled, but will allow for faster interaction.

Entering letters in a PDA can also be time consuming. Since it is needed to search for a particular building, person, or event, we decided to add a feature that allows you to get the name of a building by touching it on the map. We suspect this might be a faster method of selecting a destination if you know the general area but not the specific building. Along with the name of the building, a menu also appears allowing you to plot the building on the map or create a route from your current location to this building.

The following is a list of features we rejected:

- **AR Overlay:** Surveyed users liked the original AR design because its interface was so easy to learn: as you traveled the campus, a highlighted route was overlaid directly on the surrounding environment. We tried to port some of this design to the PDA by incorporating pictures of all campus intersections into the device. These could then be displayed upon the screen at the user's request; with GPS the device would know the current intersection and a path or arrow could be superimposed upon the picture.

  **Reason for Rejection**: Considered overkill

- **Draw-A-Route:** The original design for gestures came from the idea that people might plot a number of destinations and then "connect the dots" to create desired maps. When tested, this option proved less than satisfactory since not all plotted destinations might be shown on the screen at any one time, and the user might be confused as to how to proceed. Also, this gesture was the same as that used for pan, the only difference being this connects two previously plotted points. Drawing a line was thought to be a more natural fit for panning, and people we surveyed didn't like the idea of similar gestures having different meanings.

  **Reason for Rejection**: Confusing, too similar to pan gesture
- **Pan Border:** An alternative to dragging the map to effect a pan could be clicking on a border around the screen to pan the map in the direction implied by the placement of the click.

  **Reason for Rejection:** Lack of real estate
- **Text Directions:** One of our surveyed users felt that it would require too much time to use ICE while actually walking the route. He preferred to use it to create a route, give him directions and he could then put it back in his pocket. Unfortunately, too many paths on campus are unnamed, making text directions confusing. Additionally, most of our users prefer visual directions to written and oral. A user can see the route on the map, understand where he needs to go, and then put the PDA back in his pocket.

  **Reason for Rejection:** Difficult to include unnamed paths in text directions.

# Description of the Interface

### Main Screen

At startup you are presented with a full—albeit small—map of the campus. A highlighted, blinking icon labeled “YOU” represents your current position on the campus. As you move, so does the icon, which continually tracks the PDA’s position.


From this screen you may zoom in or out, pan, probe buildings to display their names, select or search destinations, display building information, plot a destination and create a route to it, specify advanced search or route options, center the map to your current position, and define preferences.

### Auto Pan

While en route, the icon representing the current location will be updated on the map. If the map is zoomed-in so that only some portion of the full map is showing, the icon will not move. Rather, the map will scroll so that the icon stays in the center of the screen.

**Search**

If you enter one or more letters in the destination box and press “Search,” you are presented with a screen listing the returned search result. This screen lists all items with names that contain the search field, in “best-fit” sequence. From this screen, you can select an item and plot its location on the map, create a route from your current location to it, retrieve information about the item, or take no action and return to the map.

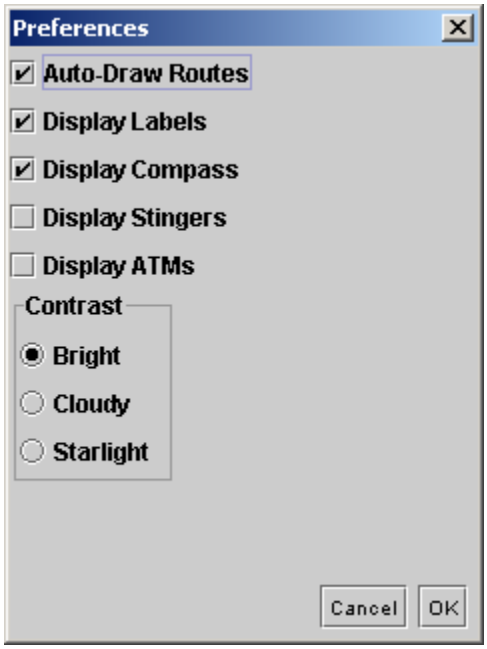

**Advanced Options**

By choosing “Advanced”, you are presented with a screen that offers advanced search and route options. Selecting one or more options may narrow your search to buildings, departments, people, and events or some combination. You can also browse any or all of these categories. You can pinpoint the browse by entering a starting point in the text box at the top of this screen or the subsequent browse screen. Entering “Bu” might start the browse at “Burdell, George.”

The Advanced Options screen also allows you to specify route criteria. You may request a “no-stairs” route optimized for wheelchair and bicycle users, a well-lit path, or an automobile route.


**Options Menu and Preferences**

Any of these search or route options may be defined as defaults by updating them through the Options pull-down menu. A Preferences screen is accessed through the menu that allows modification of several displays: Stinger and ATM positions, labels identifying plotted points, and a compass arrow that points north. A contrast choice optimizes the display's contrast for bright sunlight, clouds or nighttime use. Auto-draw controls whether routes are plotted automatically as destinations are added or whether the user determines when to plot a route.




**Information**

An information screen provides detailed information for the selected item. Buildings, events, people, and departments might provide differing information such as address, phone number, office hours, depending upon what is in the database for that item.

**Help**

Context-sensitive help is available from any screen. From the main screen, you can access a Help screen by clicking the "?" button. The context is dependent on the selected mode. From other screens, you can access help through the Help Menu option. You can return to your previous location by clicking the "Return" button on all Help screens.

# Using ICE

You can operate ICE in two distinct ways. You may select tools from a menu and use them to manipulate the map, or you may perform different gestures on the map to get the same effects.

**Tools**

Selecting a tool button on the map screen places you in one of several stylus modes: zoom-in, zoom-out, and pan. These tools determine the action that takes place when the

stylus subsequently interacts with the map. When a tool is selected it sets the mode; for action to take place a second gesture is needed.

 Clicking on the map in zoom-in mode will show an enlarged section of the map centered on the selected point.

 Clicking on the map in zoom-out mode will show more of the map centered on the selected point. Map items will look smaller.

 Clicking on the hand enables you to drag the map in pan mode.

However, the default mode is “Draw” mode, a gesture-based mode that provides shortcuts and eliminates the need to select tools.

 A pencil represents draw mode. Multiple actions are supported in this mode; each action differentiated by the gesture drawn on the screen. This mode supports pan, zoom in, zoom out, probing location names, and getting detailed information for a plotted location. The following table describes the gestures.

| *Action* | *Gesture* |
|---|---|
| Zoom in | Draw a circle on the map. The map zooms in on the enclosed area. *(The drawn object does not need to be a perfect circle but does need to begin and end in roughly the same place.)* |
| Zoom out | Draw an arrow pointing upwards (^). The map zooms out. |
| Pan | Draw a line on the map. The map is pulled in the direction of the line. |
| Probe Building Name | Hold the stylus on an unplotted building. The building’s name and a pop-up window will be displayed. When the stylus is lifted, the name and pop-up window disappear. |
| Get Detailed Information | *Unplotted building:* Hold stylus on building. When the pop-up menu appears, drag to the “Get Information” option. The information screen will be displayed.<br>*Plotted building:* Click on the icon representing the plotted building. The information screen will be displayed. |

| | |
|---|---|
| Plot the Building | Hold stylus on unplotted building. When the pop-up menu appears, drag to the "Plot on Map" option. An icon representing the building and a descriptive label will be displayed. *(This option only appears if Auto-Draw is off.)* |
| Create Route | Hold stylus on the building you wish to go to. When the pop-up menu appears, drag to the "Route to here" option. A route from your current location to this building will be displayed. |

Three scenarios are provided to show alternative ways to accomplish the same task using the ICE system.

**Task:** You are at the Student Center and want to reach the Graduate Living Center via a well-lit route.

**Scenario 1: Tool Selection**

1. The main screen is displayed. It shows that you are at the Student Center. To find Graduate Living Center on the map you use the stylus to enter "Grad" in the search field
2. Select "Search".
3. A list of possible matches appears. You select "Graduate Living Center".
4. Still on the returned list screen, you select the "Route Options" button.
5. On the "Route Options" page you check the "well-lit" route option box.
6. Select "Plot and Route" to create the route and return to the map.

While negotiating the route, you come to a tricky intersection.

7. You select zoom-in mode and click on the map near the intersection to zoom in. You continue clicking until you get to the desired zoom level.
8. Once you find your way, select zoom-out mode and click on the map until you can observe the full route.

**Scenario 2: Gestures**

*Repeat steps 1 - 6 above to create the route.*

While negotiating the route, you come to a tricky intersection.

7. You draw a circle around the intersection to zoom in.
8. Once you find your way, you draw a "^" on the map to zoom out.

**Scenario 2: Probing**

1. You have an idea where the Graduate Living Center is located. You press down on buildings in the area to view their name. "Grad Living" appears.
2. Drag stylus to the "Route to here" menu option.
3. Use gestures to zoom in and out as needed.

# The Future of ICE

Given the scope of this project, we could not include all of our ideas into the design. However, it may be appropriate to prototype these features in future versions of the ICE system.

- **Wake-up at a Turn:** With GPS, the device can alert you to turns you need to make while walking the path. Create a route, put ICE back in your pocket and it will beep or vibrate when turns need to be made. You can set it to beep once for left, twice for right; set different sounds for different instructions, or set varying vibrations to get the ultimate massage while walking to your destination.
- **Dynamic Update of Route:** You see a friend while walking the route and wander off the path to spend some time with him. ICE automatically determines a second route to your destination and superimposes it on the screen, perhaps in a different color than the original route. Alternatively, your original route is altered.
- **Plot Route from Alternate Starting Point:** Our initial surveys indicated that people might use this to plot an immediate route and not to create several routes from consecutive starting points to plan their days. This seems like a valuable feature but would be for expert users and was not required for the prototype.
- **Add Scale to Map:** We need to evaluate whether users would want a ratio scale either overlaid on the map or above it, perhaps at the expense of real estate.

# Evaluation Techniques

### Hypothesis

We believe that using the Interactive Campus Envoy (ICE) handheld application will allow users to locate buildings on campus, navigate to locations on campus, and find information about the campus faster than the existing system and will be a more enjoyable experience for our users.

### Usability Specifications

Overall, users should:

- Be able to determine a route from point A to point B using the ICE device in equal or less time than the existing system.
- Indicate they prefer the ICE device to the existing system.
- Report they were able to learn how to use the ICE system within a reasonable amount of time.
- Indicate that gestures would improve speed.
- Indicate that gestures map appropriately to their actions.

### Procedure

To test our hypothesis, participants will be recruited and asked to take a demographic questionnaire designed to match them on PDA and mapping software experience. From this sample at least 6 participants will be matched and randomly assigned to one of two groups. They will participate in a laboratory experiment designed to compare our system's learnability and usability to that of the existing interfaces. Following each experiment, the user will complete a questionnaire assessing their opinions regarding usefulness, usability, and satisfaction.

Our laboratory design will have two parts. We plan to do a within-groups experiment with timed tasks to compare our system to the existing system. We also want to compare relative efficiency and satisfaction of gestures vs. tools within the ICE system. Since we anticipate a learning effect as users learn a second mode, we will create two groups of users. One group will learn gestures first and be timed only when using

gesture mode; the other group will learn tools first and be timed only in that mode. These timings will be compared against those captured with the existing system. Once timings are complete, each group will then learn the second ICE mode so we can query them regarding their preference. Our design will compensate for order effects in the within-group test.

Each of the following tasks will be done for at least one of the existing interfaces, the paper or online campus map, and also for our PDA device. Users will be given time to learn each system by interacting with it. To guide the interaction, we will provide a checklist of tasks such as zoom in on the map and search for College of Computing that the user should figure out. Our measure of learnability will be the total time elapsed from the start of interaction to completion of the checklist.

To determine usability we will measure the time it takes the participant to complete another list of tasks. These may be tasks such as:

- Find the name of a random building on the map
- Obtain information about a building, person, or event
- Create a route to a destination
- Create a route using an advanced option

Participants may be asked to think aloud while learning the system but not while performing the timed tasks so as not to interfere with the results.

**Post-Test Questionnaire**

Upon completing the experiment the user will be asked to fill out a questionnaire. We will solicit feedback on usability, usefulness and satisfaction. Sample question might include:

The icons were easy to recognize.

| *Disagree* | | | | *Agree* |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

When I clicked on the map the application responded the way I thought it should.

| *Disagree* | | | | *Agree* |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Did you prefer using the tool buttons or the gestures for zooming and panning? *Please explain.*

____ Tool buttons ____ Gestures

Which of the items below would you more likely to use in the following situations?

1. Paper Map
2. Online Map
3. Ask People
4. Interactive Campus Envoy (ICE)

____ Going to an unfamiliar place on campus

____ Finding information about a person

Would you use the Interactive Campus Envoy (ICE)? *Please explain*.

Circle a number representing how much you enjoyed using the ICE system to accomplish the tasks.

| *Did not enjoy* | | | | *Greatly enjoyed* |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Circle a number representing how much you enjoyed using the GT online map to accomplish the tasks.

| *Did not enjoy* | | | | *Greatly enjoyed* |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Did anything annoy you about the ICE system? *Please explain.*