Adapting Interfaces Based on User Needs

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Outline

- Motivation
- Defining Users
- Defining Tasks
- Interface Types
- Our Work
- Interesting Issues

Motivation

Our motivation has been large scale operations that employee a large diverse workforce, e.g., US Census decennial tasks.

The decennial census requires 500,000 to 750,000 temporary workers with just a few weeks to complete the operation.

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Defining Users

- Individual differences
- Physical impairments
- Age
- User State

Individual Difference Categories

- Physiological
- Psychological
- Sociocultural

Benyon, Crerar, Wilkinson 2001

Fixed Individual Differences

Physiological
- Gender
- Height
- Cerebral Hemisphericity

Psychological
- Intelligence
- Personality

Sociocultural
- Ethnicity

Stable Differences

Physiological

- Handedness

Psychological

- Cognitive Styles

Sociocultural

- Language

Changeable Differences

Physiological

- Handwriting
- Speech

Psychological

- Personal Knowledge
- Behavior

Spatial Ability and Interfaces

Spatial ability, especially visualization, has often been cited in the HCI literature as being related to computer performance

- Vicente et al., 1987
- Campagnoni and Ehrlich, 1989
- Seagull and Walker, 1992
- Sein et al., 1993
- Stanney and Salvendy, 1994,1995

Interesting Result (Benyon et al. 1993)

Subjects performed retrievals on two interfaces

- Command line
- Menu

Subjects with high spatial ability scores performed significantly better on the command line than the low spatial ability subjects.

What does the performance on the command line mean?

Subjects with high spatial ability seem to be more able to "discover" the structure of the underlying software than subjects with low spatial ability.

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Spatial Ability and the Task

The task is critical for performance

Phillip Ackerman's model of skill acquisition (1988) hypothesizes that there are 3 levels:

- Spatial, verbal and numerical ability
- Perceptual speed
- Psychomotor abilities

It seems to hold for simple repetitive tasks, but doesn't hold for more complex tasks that repeatedly require the subject's abilities.

Task States

- Control tasks are examples of tasks that have states that can be detected.

Relying on both the System and User

- Viano et al. used the state of the system and the state of the user in their Auto-Adaptive Multimedia Interface (AAMI) to adapt the information content showed to the user.

  Viano, Alty, Angulo, Biglino, Crampes, Daurensan, Parodi, Khalil, Vaudry, Lachaud. 2004

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User Interface Types

- Traditional
- Inclusive/Universal
- Adaptable
- Adaptive
- Situation-based Interfaces

Traditional Interfaces

- Main weakness is that they are the computer programmer's attempt to get all functionality one or two clicks from the start screen.
- Main problem is that while programmers think that way, users usually don't.

Inclusive/Universal Interfaces

- Main idea is for the interface designers to do an inclusivity analysis to determine the solutions (hardware, software, training, etc.) available and their costs.
- Solution set can be targeted to the likely users.
- Inadvertent exclusion will be eliminated.

Adaptable Interfaces

- The focus is to provide multiple features that either the user or the individual that provides the software/hardware sets the available parameters to optimize performance.
- Main problem with adaptable interfaces is that it is numerous studies have shown that users tend to misinterpret their abilities.

Adaptive Interfaces

- Adaptive interfaces react to the needs of the user based on the user's action.

- A useful definition:

  "Adaptive systems are systems which can alter aspects of their structure, functionality or interface in order to accommodate the differing needs of individuals or groups of users and the changing needs of users over time."

  -> Benyon, Innocent , Murray 1987.

Variations of Adaptive Interfaces

- Intelligent User Interfaces
  - Covers a wide range of intelligence.
- Active User Interfaces
  - Adaptive based on expert system/ machine learning.
- Context Aware Interfaces
  - Sense and detect context informations, e.g., situations.

Determining User Abilities

- User actions
  -> user action patterns
  -> user errors
  -> state of user/system
  -> situations

Situation-based Interfaces

- An offshoot of adaptive interfaces.
- The focus of this approach uses situations as the actions that the software uses to decide how to adapt the user interface (Chang, et al. 2009)
- The work builds on Situation-Aware Service-based Systems (Yau and Liu 2006, Yau, Gong, Huang, Gao, Zhu 2008, Chang, Jiang, Ming, Oyama 2009)

Multiple User Interface

- Provides multiple views of same user interface across multiple hardware/software platforms.
- We see this type of interface on our mobile devices and laptops/desktops.

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Our Work

- Error-based adaptive web pages
- Adaptive map-based software for Census operations
- Cross platform models for porting user interfaces.

Error-based adaptive web pages

- The focus of the work has been on making web pages more useful to older adults by adjusting the web pages based on a user profile.
- We developed a screen real estate index to index the components on the web pages and an error detection strategy for vision and motor skill errors.

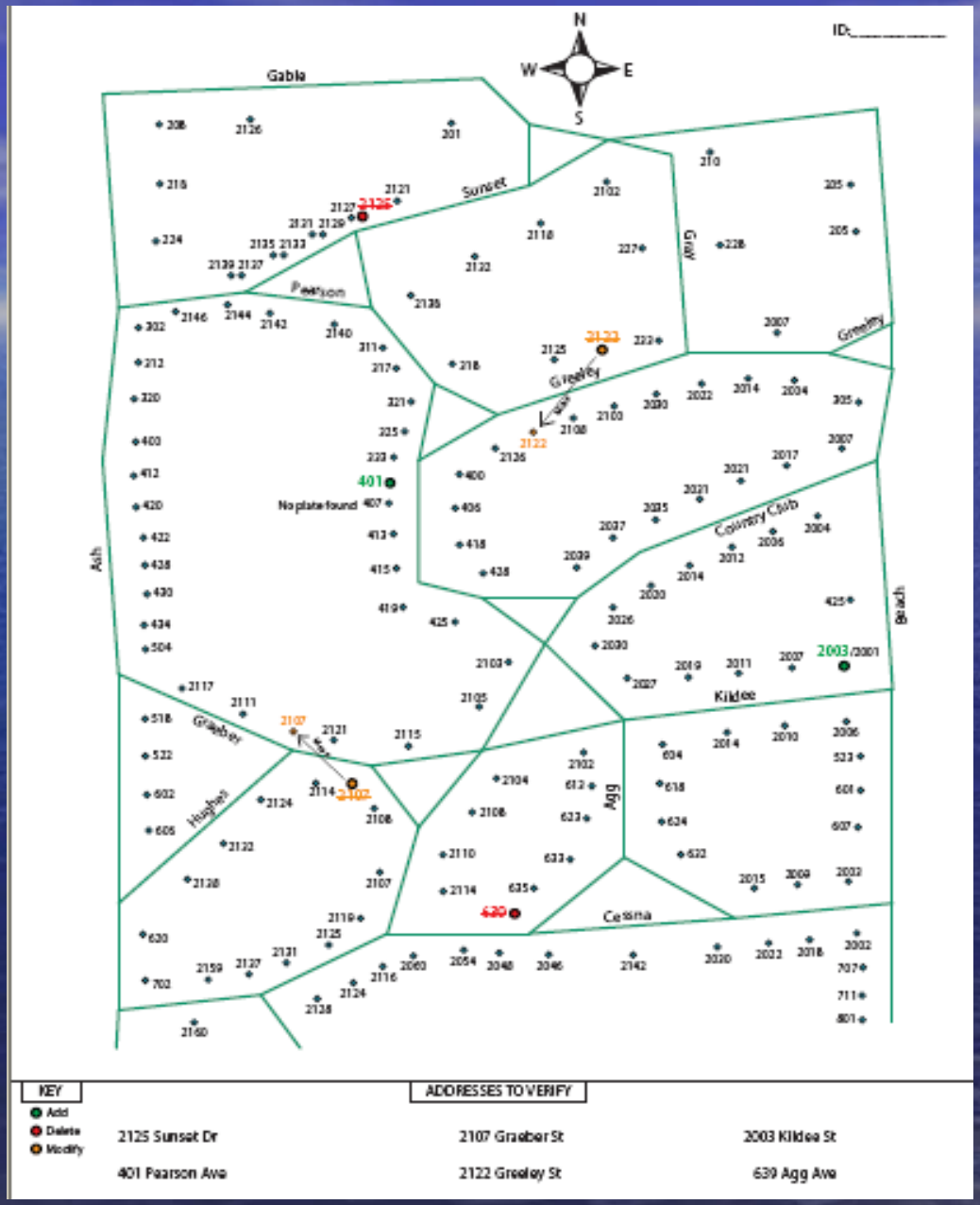
Error-based adaptive web pages

- The error detection strategy was compared to traditional approaches such as self assessment of the users, testing, and observation.
- The error detection strategy significantly outperformed self assessment and testing.
- Perhaps more important, in our tests we found it to be statistically equivalent to observation.

Understanding Task and User Needs for Address Verification

- Paper map study
- Handheld study with no physical navigation (includes text-based guidance)
- Handheld study with field navigation
- Handheld study with virtual reality navigation

Paper Map Study



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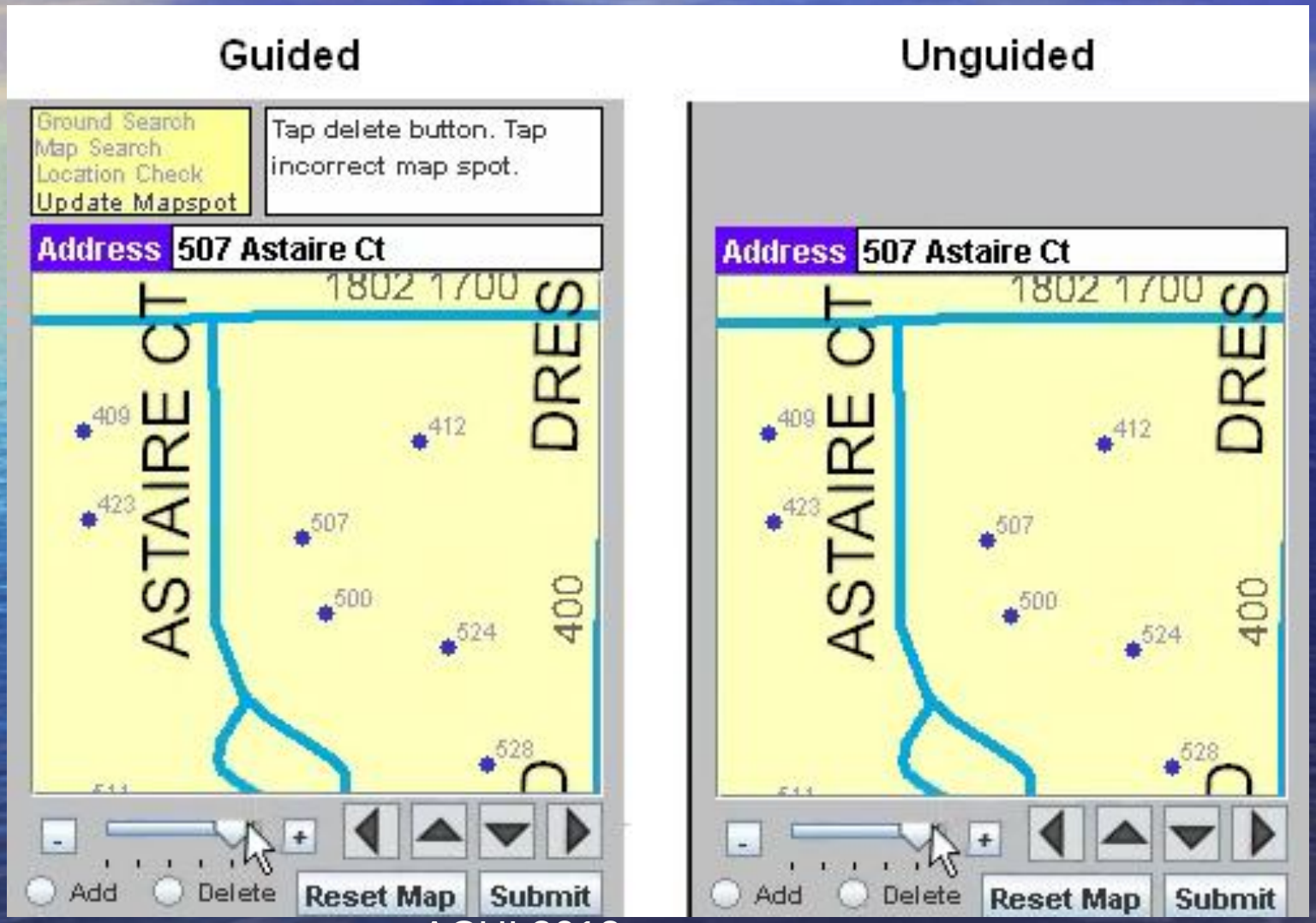
Handheld with no navigation

Census Address Verification



Adaptive map-based software

- We are currently looking at two means of identifying user needs in map-based United States Census applications.
  -> Identifying the spatial ability of the users
  -> Building on our previous work on error detection

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Some Interesting Issues

- Recognizing action patterns that result in higher user performance, e.g. spatial ability.
- Adaptive interfaces that rely on interactive devices.
- Recognizing situations in situation-aware systems.
- Cross platform adaptive interface models.