
Mobile Application for Utility Domains

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Abstract

This work, a collaboration between MIT and ABB/Ventyx, is focused on the development of a mobile interface for field workers in power repair settings and field service delivery. A Human Systems Engineering (HSE) approach of Plan, Analyze, and Design was utilized to develop the interface, which included a hybrid cognitive task analysis (hCTA) that identified requirements for the envisioned interface. This paper presents an overview of the results of three stages of the HSE process and presents a preliminary design for the mobile interface that emerged during initial display prototyping. Next steps for the project are also discussed.

Keywords

Information requirements, cognitive task analysis, decision ladders, human systems engineering

ACM Classification Keywords

H5.2. Information interfaces and presentation: User Interfaces – *Evaluation/methodology, Graphical User Interfaces (GUI), Prototyping*; H1.2. Models and principles: User/Machine Systems – *Human factors*.

General Terms

Human Factors, Design

Introduction

This effort is focused on developing a mobile interface that extends the functionality of existing distribution network management tools in the power utility domain

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such that field workers can access relevant and timely information. A Human Systems Engineering (HSE) approach, featuring the three phases of Mission Planning, Analysis, and Design, was utilized to develop the new mobile interface, and focused on improving both efficiency and usability of human-machine interaction with the mobile tool.

Phase 1: Mission Planning

This work began with site visits to ABB/Ventyx customers to gather firsthand information concerning current operational cognitive needs. Site visits were made to two utility companies, CPS Energy in San Antonio, TX and DTE Energy in Detroit, MI. During these visits, our research team participated in ride alongs with troublemen who are first-responders focused on resolving short-order low power voltage issues. The collected data identified the need for a redesigned mobile application to follow basic interface design principles, while also overcoming the limitations of current vehicle mounted laptop displays. This tool would benefit workers, possibly reduce operator frustration, and increase overall operational efficiency. The collected data was used in Phase 2 of the HSE Process to construct workflows for the troublemen and derive requirements for the mobile application.

Phase 2: Analysis

A Hybrid Cognitive Task Analysis (hCTA) was used to gather requirements for the mobile application [1; 2]. The hCTA method consists of three overall phases: 1) Task Overview, where the workflow of the human is identified and broken down into phases and tasks, 2) Task Analysis, where the information needed by the human to successfully perform the identified tasks is determined, and 3) Requirements Compilation, where

all identified information needs are compiled into a single list of requirements to guide the interface design.

The workflow tasks of troublemen were broken into five distinct phases: 1) Issue Selection, 2) Navigation to Issue, 3) Issue Review, 4) Issue Diagnosis, and 5) Issue Completion. Within each phase, a number of individual tasks were identified and organized into a workflow diagram to visually convey the temporal relationships and constraints between the tasks.

Next, the data required to successfully complete each of the workflow tasks was identified. This data was identified in two steps. The first step was defining the situation awareness requirements, which dictate the information necessary to maintain the three levels of situation awareness: 1) Perception, 2) Comprehension, and 3) Projection [3]. In all, 24 situation awareness requirements were identified. Concurrently, decision ladders were developed. Decision ladders are created for each complex decision identified in the workflow process to better understand the information required to support the operator faced with such a decision [4]. In the power utility domain, a two-part complex decision was identified: *Can issue be identified?* AND *Can issue be resolved?*, with the decision-making process mapped using a decision ladder. Resulting display requirements numbered nine.

The final list of requirements for the mobile interface numbered 50. As the information requirements were derived directly from operational tasks, the resulting list of requirements can be deemed to represent all data the human operator would need to respond to and resolve power outage issues.

Phase 3: Design

Design principles [5] and usability heuristics [6-8] were referenced during display development, which progressed from basic wireframes to a medium-fidelity design. All 50 identified requirements were included in the mobile interface, which was developed for the Samsung Galaxy Tab (7-inch display, Android OS).

The resulting display included four main functional groups (Figure 1): 1) Title Bar summarizing high-level user details, including current time and status, 2) Workflow Phases, identifying the current operational phase of the worker (e.g., Issue Selection, Navigation to Issue, etc.), 3) Main Content Bar, providing key details related to the current operational phase, and 4) Interaction Bar, including icons for interacting with the control room and other field workers through phone or message, checking the wireless network service, and entering emergency status. As the mobile application has been designed for a tablet, it will be viewable in both Landscape and Profile mode.

The redesign of the current distribution network management tool offers many advantages to field workers in utility domains. Some of these advantages are directly associated with the choice of display technology. A mobile tablet device allows the operator to utilize network data both inside and outside the vehicle, unlike current heavy ruggedized laptops.

Another unique aspect of the mobile display technology is the ability to take pictures and record audio/video that can be associated with a particular case. Such information can be transmitted in real-time so that command centers can develop more responsive contingency plans. In addition, other operators nearby

could also have access to this multimedia content, which could promote a more decentralized approach to problem solving such that a nearby crew may be able to solve a problem without lengthy communications delays. This kind of multimedia use is critical in the development of shared situation awareness so that others user of the system can have a better understanding of where a particular problem exists and what needs to be done to remedy it.

Next Steps

The next step will be to evaluate the current design, which will be tested using the Cognitive Walkthrough evaluation approach [9] utilizing experienced troublemen. Once feedback on the prototype has been gathered, another design iteration will occur.

While this initial research targeted a specific field worker group (i.e., troublemen), workers in other domains, such as communication environments and plant operations could also benefit from such a device. The design of a *universal mobile application*, for varying worker types, will also be the focus of future work. Ideally, an hCTA would be performed for each representative stakeholder that would utilize the *universal mobile application* device, with a common set of display requirements for all domains collected and used to guide the design of the device. In the coming months, the currently completed analysis will be expanded to include disparate worker groups, allowing for a more complete workflow analysis and a set of requirements to guide this *universal mobile application*.

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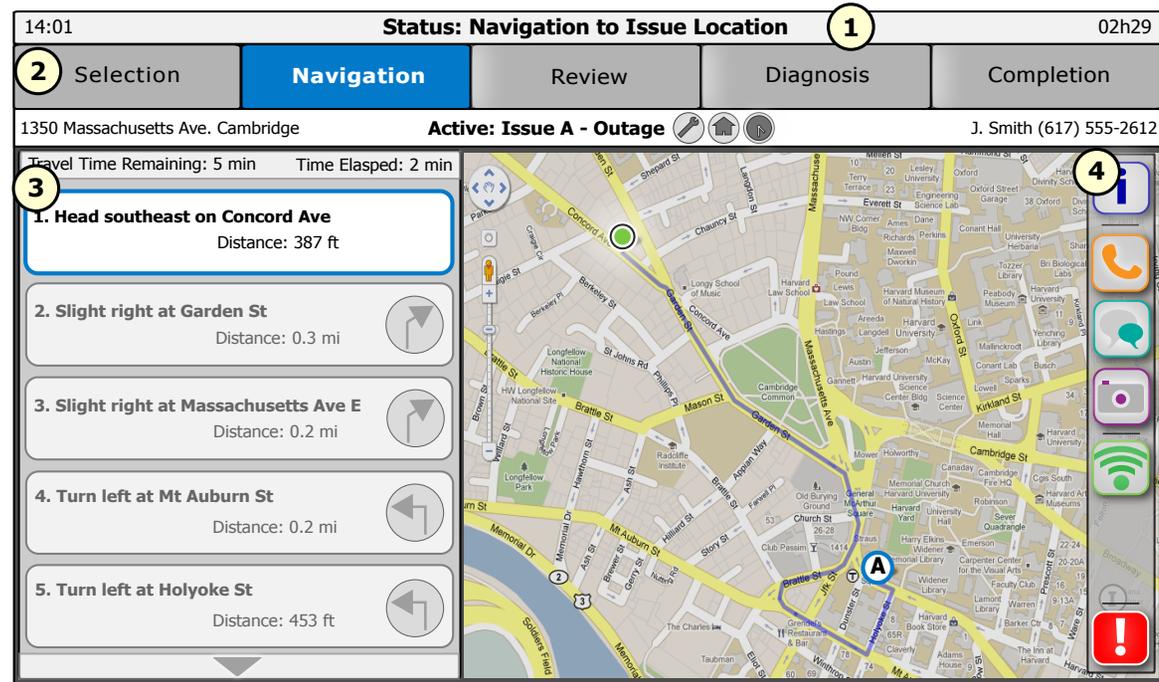


Figure 3. Annotated prototype display in landscape mode.

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