Applied Ergonomics 44 (2013) 895–908

Contents lists available at SciVerse ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

Using a 'value-added' approach for contextual design of geographic information

Andrew J. May*

Loughborough Design School, Loughborough University, Ashby Road, Loughborough LE11 3TU, UK

ARTICLE INFO

Article history:
Received 28 February 2011
Accepted 26 October 2012

Keywords:
Information value
Geographic information
Vehicle navigation
UCD
Added-value

ABSTRACT

The aim of this article is to demonstrate how a 'value-added' approach can be used for user-centred design of geographic information. An information science perspective was used, with value being the difference in outcomes arising from alternative information sets. Sixteen drivers navigated a complex, unfamiliar urban route, using visual and verbal instructions representing the distance-to-turn and junction layout information presented by typical satellite navigation systems. Data measuring driving errors, navigation errors and driver confidence were collected throughout the trial. The results show how driver performance varied considerably according to the geographic context at specific locations, and that there are specific opportunities to add value with enhanced geographical information. The conclusions are that a value-added approach facilitates a more explicit focus on 'desired' (and feasible) levels of end user performance with different information sets, and is a potentially effective approach to user-centred design of geographic information.

© 2012 Elsevier Ltd and The Ergonomics Society. All rights reserved.

1. Introduction

1.1. Background

Advances in digital mapping, positioning, communications networks and highly portable computing devices are enabling increasingly ubiquitous access to geographic information. There is now a wide range of commercially available location-aware products and services that enable individuals to use geographic information for work or leisure purposes. Vehicle Navigation Systems are one such example of mobile computing that is now commonplace in modern vehicles, either as original manufacturer fitment, aftermarket personal navigation device, or as an application on a smartphone. They use positioning technologies and a navigable map database to provide turn-by-turn and/or map-based information to a driver to enable them to navigate to an unfamiliar destination. Walker et al. (2001) describe how Vehicle Navigation Systems 'facilitate more rational use of the road network by offering drivers decision support'. From a geographic perspective, they are a technical system falling under the broad category of data dissemination (Goodchild, 2009).

Over two decades ago, Lunenfeld (1989) and Wierwille et al. (1989) identified a range of human factors issues with Vehicle Navigation Systems. Since then, a number of authors have addressed issues to do with their user-centred design (Lavie et al., 2011; Kun et al., 2009; May and Ross, 2006; Lansdown et al., 2004; Burnett, 2000; Jackson, 1998; Burns, 1998; Green et al., 1995; Fastenmeier et al., 1994).

Most human factors research has taken a safety/usability approach, incorporating measures of driver and vehicle performance. Indeed there has been recent effort to generate a usability evaluation framework and toolkit for in-vehicle information systems (Harvey et al., 2011). However, a limitation of a usability perspective is that it does not place explicit focus on the link between presentation of information to the driver (from within and outside of the vehicle) and drivers' decisions and actions at specific manoeuvres.

An alternative (or complementary approach) to the design of in-vehicle information systems such as vehicle navigation is to treat them as decision support systems. Rather than being an *interface*, they are treated as one of several sources of information, used by drivers to make routing decisions at points of navigational uncertainty. The 'decision support system' is being used in the presence or absence of a wide range of other geographic information cues that will have impact on the navigation decisions and courses of action that drivers take.

The key difference between a decision support system used within a vehicle and those used in more traditional environments such as financial planning, medical diagnosis and operational research is that with in-vehicle systems the interaction with the device is not usually the primary task of the driver. Simply providing more navigation information at driver decision points

* Tel.: +44 1509 226906; fax: +44 1509 226960.
E-mail address: a.j.may@lboro.ac.uk.

0003-6870/$ – see front matter © 2012 Elsevier Ltd and The Ergonomics Society. All rights reserved.
http://dx.doi.org/10.1016/j.apergo.2012.10.012

does not necessarily benefit the driver, due to the multitasking environment (Fastreza and Haue, 2008) and the limited processing resources that humans have. Research into how humans benefit from geographic information has shown that 'less' can be 'more' (Meilinger et al., 2007). However there is a current trend for greater complexity of navigation interfaces, an example being the move towards presentation of 3D or photo-realistic views of the terrain, as highlighted by Kun et al. (2009). This potentially conflicts with the point highlighted by authors such as Marcus (2004) – the need for safe, simple and direct navigation instructions.

1.2. Aims of study

The overall aim of this study is to present an alternative perspective on the user-centred design of geographic information that takes into account the wider geographical context that such systems operate within. More specifically, the study uses a 'value-adding' framework to help understand how geographical information provides benefit to drivers navigating an unfamiliar route. The intention of the article is to introduce a new approach, rather than to focus entirely on the design of navigation systems.

The specific objectives of the study are to:

- Summarise the different value related concepts and show how they may be applied within a driving context
- Measure the driver performance outcomes and variability over the course of an unfamiliar route using a benchmark information set
- Identify the key contextual factors related to the physical environment that influence the variance between observed and desirable outcomes
- Identify the value that additional or enhanced geographic information plays in maximising driver outcomes

2. How geographic information adds 'value'

2.1. Value concepts

The term 'value' or 'added-value' is often used in relation to consumer products, and has a number of different definitions according to the theoretical background of the research. For example, in retailing and marketing Zeithaml (1988) defines perceived value as 'the consumer's overall assessment of the utility of a product [or service] based on perceptions of what is received and what is given' and describes how 'value represents a trade-off of the salient give and get components'. Sweeney and Soutar (2001) describe value as comprising dimensions of emotional, social and functional value. Lin et al. (2005) review different conceptions of value, and conclude that value comprises multiple 'give-get' components – and is measured in terms of those components – rather than being a construct which can be measured directly. Within HCI, Cockton (2004) has used the term 'value' to describe what is worthwhile for end users, and then later (2006) as a 'unifying concept for design'.

Different perspectives on 'value' come from Information Science where there are (1) a number of different definitions that can be employed, and (2) considerable challenges in the design and evaluation of information (Raban, 2007). Sheridan (1995) describes how information value is that which arises from using information – in terms of 'what one pays to acquire information together with what one earns by taking action based on it'. The importance (and complex context) of information value is demonstrated by Hollnagel (1988) when he describes the need to provide the right information at the right time for users, and the observation by Flach et al. (1998) that the challenge is to determine what 'right' means.

Ahituv et al. (1994) describe three perspectives on information value: normative (quantitative calculation based on probabilities and expected costs and payoffs); realistic or revealed (outcome measure, based on differences in performance); and subjective (individual judgement of its worth). They make the key point that no matter how information value is defined, 'it is a relative value, based on comparisons between payoffs gained under different sets of information'. Koops (2004) also describes how the value of information 'is not affected by variance in the possible states of the environment, but rather by variance in the available actions'. He highlights that value is derived from the potential to undertake difference forms of behaviour – if there is no possibility of an individual undertaking a different set of actions if supplied with information, then the value of that information is zero. This mirrors Bateson (1980), when he defines information as being 'any difference that makes a difference'.

It is possible to incorporate the notion of *desired* outcomes within an information value framework. Koops (2004) describes how 'the value of correct information …… is the difference in payoff obtained when informed versus uninformed'. More specifically, Karim (1997) describes how the concept of *the expected value of information* (EVOI) is defined as the 'expected increase in the value (or decrease in the loss) associated with obtaining more information about quantities relevant to the decision process'. The expected value of information is therefore a measure of the importance of the uncertainty about a quantity in terms of the expected improvement in the decision that might be obtained from having additional information about it.

In summary, an information value approach is being used within this study since a vehicle navigation system is an information appliance that is designed to impact on driver outcomes. The concept of realistic or revealed value is used, focussing on driver outcomes, and the term 'added-value' is used to describe the differences in driver outcomes resulting from different sets of geographical information.

2.2. Application within a driving context

Within a driving context, there has been surprisingly little explicit application of a value-based investigation of information provision to drivers, and associated outcome measures. This is despite the fact that navigating an unfamiliar route clearly displays the variance in possible driver actions that is needed for information value to be meaningful (Koops, 2004).

In relation to turn-by-turn navigation, a driver's basic need is for *preview* information that prepares a driver for the turning (e.g. lane keeping and speed control), *identifying* information to locate a turning, and *confirming* information that identifies whether a correct turning has been made (Burnett, 1998). A large number of studies have identified in general terms the geographic information that is useful for driver navigation. Drivers have stated preferences for road names, landmarks, junction layout, place names and road numbers (Burns, 1998; Burnett, 1998). In particular, good landmarks, including traffic lights, have been shown empirically to be effective for identifying the location of turnings (May and Ross, 2006; Ross et al., 2004; Burnett, 2000).

However, there have been relatively few studies that have investigated how the context of the particular manoeuvre influences the geographic information that is, and is not useful in that situation. Frank (2003) describes how the level of knowledge a driver holds influences the level of content that is useful for navigation purposes. He also highlights that where information is available from the world, the same content within a message may have a lower information value.

Download English Version:

https://daneshyari.com/en/article/550153

Download Persian Version:

https://daneshyari.com/article/550153

Daneshyari.com