Speedy Services: Time, Usability and E-Commerce

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Time plays a vital role in human-computer interaction. However, when interaction takes place over a network, as is the case with e-commerce, it is impossible to guarantee that temporal requirements will be met. Therefore we must look for ways in which we can enhance usability despite the inevitable delays that the user will face. In this paper we show that, by considering the users temporal experience at the interface as separate from underlying hardware and performance issues, it is possible to provide support to the user which will alleviate some of the difficulties caused by a failure to meet temporal requirements. In e-commerce the user's temporal experience at the interface is directly affected by both site design, and the functionality of the web browser. We highlight those areas of site design which impact upon the user's temporal experience, and propose a number of changes to the functionality of the web browser which would provide support for the user.

Keywords: Time, Usability, E-Commerce, Human-Computer-Interaction, Web-Browser, Temporal Requirements

1 Introduction

This paper addresses the way in which temporal issues affect usability for e-commerce. Users' emotional responses are strongly affected by temporal experience at the interface to the World Wide Web (WWW), with delays and temporal inconsistency evoking powerful negative reactions. There is evidence that outside the area of hard real-time systems, consideration of performance and response issues is lacking (Lubars et al 93). These issues must be addressed if e-commerce is to meet predicted expectations.

In any system where interaction takes place over a network (particularly the WWW) there is no way of guaranteeing that hard temporal requirements can be met. Delays in accessing information can be caused by communications failure, network loading or processor overheads (Johnson 95). Therefore, we must look to ways in which the user may be supported where temporal requirements cannot be met. In order to do this we must separate the users' experience at the interface from system performance issues, a concept known as 'two-timing' (Dix 87). For e-commerce, we believe that this means that a two-pronged approach is necessary. As the user's initial point of interaction is via the web browser, this should become the primary line of attack to improve usability and support user preferences. The browser is the vehicle via which the user reaches an e-commerce site; if it is inadequate for its purpose users will simply not visit such sites. Secondly, site designers must take into account the ways in which design can impact upon the user's temporal experience. The combination of these two approaches provides enhanced usability even in situations where strict timing requirements cannot be met. The recent merger between AOL, owners of the Netscape browser, and Time Warner, gives a single company the power to enhance usability at both of these levels, although these suggestions are of course relevant to all e-commerce and browser developers.

In the rest of this paper we:

- explain the significance of temporal issues in interaction in more detail, providing a number of examples of how this may impact upon e-commerce
- present a description of how the design of e-commerce sites can affect the user's temporal experience
- suggest a number of ways in which additional functionality in the web browser can provide support to the user. We include functions that are user-definable, giving users the power to tailor the browsers' behaviour to support individual preferences.
- discuss the impact of these proposals for those involved in e-commerce, and identify directions for future work

1.1 Definition of Terms

For the purposes of this paper 'temporal issues' are defined as including both specific temporal requirements (for example, the system shall respond to action X within Y seconds), and the more general notion of timeliness, which refers to the ability of a system to act or respond 'in good time'. We use the term system to refer to both systems and applications.

2 Time and Interaction

Time plays a fundamental part in interaction between the user and system, and temporal properties of interaction should strongly influence interface requirements. The system's potential for supporting different user strategies (or goal trajectories), and the system's demand on user memory are significantly affected by timing, particularly system or user delay (Parker 97). For example if the rate of interaction is too slow the user's execution/evaluation loop is broken (Dix 94a). This can lead to the user forgetting what must be done before the task is completed. The user generally expects feedback, informing him of what has happened, but at a very slow level of interaction it may be that nothing has yet happened. Thus, once a response finally arrives, the user must recall the appropriate context, which he may have difficulty doing. The relationship between time and interaction is of particular importance in multimedia applications, networked or distributed systems, and use of the World Wide Web. A small pilot study (Byrne & Picking 97) surveyed and analysed the issues which Web users regard to be of central importance. The results indicated that users consider temporal issues to be intrinsic to usability. Below, we consider the ways in which time impacts upon interaction in more detail.

2.1 Two-Timing

Dix (Dix 87) has suggested that there may be no relation between the user's appreciation of time and the actual execution times of internal machine events. The traditional notion that increased computational power is all that is required to improve temporal qualities of interaction is questioned, and indeed in a further paper (Dix94b) it is noted that hardware insufficiencies have largely been overcome by advances in technology, only to for us to be faced with similar temporal difficulties as a result of the increase in networking and its associated delays. Temporal issues are too entwined with usability for us to dismiss them on the assumption that technological advances will in themselves solve the problem. The fact that, in the user's view, the hardware hurdle has been overcome simply to be replaced by a network hurdle causing similar problems, emphasises the point that the user experience should be separated from hardware issues. As we demonstrate below, it is possible to reduce the disruption to the user which is caused by our inability to eliminate delays, but this will occur only if we consider the user's experience at the interface rather than expecting the problem itself to be designed away.

In a technique referred to as 'two-timing', the temporal behaviour experienced by the user, at the interface, is viewed separately from the actual temporal behaviour of system computation (Dix 87). This encourages us to think in terms of the realities faced by the user, rather than considering only those temporal performance issues that are directly under our control. If we consider the user's experience at the interface in isolation we are forced to acknowledge the inadequacies present at the interface, and are able to consider what functionality might be included to help resolve the difficulties caused. This reinforces the need for usability issues to be considered in the early stages of development when such functionality can be smoothly integrated.

2.2 Pace and Rhythm

Pace has been argued to have an important bearing on the user's experience of interaction (Dix 92). This is a temporal quality which is quite different to speed of response, the temporal property most often encountered in computer science. During interaction, channels of communication between the user and the computer are used not at a constant rate, but intermittently. Consequently, bandwidth, which assumes continuous transmission, is not necessarily an appropriate measure of communication. For example, when analysing the rate at which two individuals exchange emails, the pace of their interaction could be defined as the rate at which individual mail messages are produced. This would give us a somewhat different insight into the temporal properties of that relationship than if we were to consider bandwidth, which assumes continuous transmission, and could therefore tell us only about the average transmission of messages over a given period. Pace, the measure of the rate at which individual communications occur through a channel, is proposed as a primary property. This is an important issue with regard to interaction, which is both measurable and quantifiable, and may therefore provide a useful way of relating the pace, or potential pace, of the channels to the tasks the user must carry out.

Related to the notion of pace is the question of what time-scales humans can comfortably work to. It has been suggested (Dix 96a) that our experience of whether timings are good or bad are affected by a combination of psycho-motor abilities and external stimuli. Rhythms are easier to deal with than occasional delays and it would seem that prediction is easier if we are dealing with regular time intervals. This means that regularity may be more relevant to the user's experience than absolute response time intervals. Thus a slower but consistent interface may be more effective than a generally fast but inconsistent one.

As we noted in the introduction to section two, a very slow pace of interaction can result in the user's execution/evaluation loop being broken. An alternative scenario to delayed feedback is that a response fails to arrive at all, requiring the user to both recognise that it has failed to arrive and take appropriate action. Feedback is often delayed in open and cooperative systems. This obviously causes pace to slow and the user must therefore devise strategies to overcome the difficulties outlined. We must not only identify current user solutions for dealing with such problems, in order that new support strategies do not interfere with those (possibly subconscious) strategies currently in use, but also introduce new support systems to assist the user in overcoming these problems.

2.3 Granularity of Time

Temporal issues affect interaction at a number of different levels of granularity. At the fine-grained level we encounter issues such as status-status mappings (Dix 96b), and the need for synchronisation of different multimedia modalities to ensure that audio and video channels perform in harmony. At the coarser-grained levels we may, for example, be concerned with the rate of turnaround of messages over a period of hours, days or weeks. Somewhere in between these two levels of granularity is the level at which the system makes demands on user memory. The recorded tolerance for response from command-line interfaces is 5 seconds (Shneiderman 84), after which the user's short term memory begins to decay, and consequently longer delays place

extra demands on the user's memory, and affect the process of interaction. We raise the issue of granularity of time to illustrate that, when we consider the way in which temporal issues impact upon interaction, it is necessary to consider time scales which have not traditionally been seen as relevant in computer science.

Long-term interaction, where the rate of turnaround of individual messages may take hours, days or weeks, poses problems which are different from those found in higher pace interaction. People must remember that they have to do things, that other people should do things, and why things happen when they do (Dix et al 98). A recurrent pattern of activity is identified - request, receipt, response, release (the four R's). To illustrate: someone sends you a message requiring your action (request), you receive the message (receipt), you perform some necessary action (response) and then file or dispose of things used in the process (release). The user may have difficulty in recalling the context of a delayed response, may forget to act themselves if they cannot react instantly to a request or, if an expected external response is not forthcoming, the whole interactive process may break down. This poses questions as to how the user may be assisted with coping strategies, particularly when automating a functioning paper-based system. If we identify the triggers for these different activities, and the areas where delays are likely to occur, we may be able to minimise the disruption caused, by incorporating support for alternative strategies.

E-commerce requires us to consider a wide range of time granularities, as interaction between the user and the provider of goods and services will encompass both fine- and coarse-grained timescales. For example, when accessing an e-commerce site the user will be primarily concerned with the finer granularities, but if they go on to order goods or services then interaction may take place over a period of days or weeks.

2.4 Summary

In can be seen, therefore that temporal issues affect human computer interaction in a number of different ways. Temporal properties such as pace and rhythm may have a greater bearing on the user's interactive experience than simply speed of response, and therefore it is apparent that the temporal challenges in interaction may be quite different to those in other areas of computer science. The provision of alternative strategies for the user allows us to alleviate the difficulties caused by a lack of timeliness. This is of particular relevance where delays arise in areas which may be out of the control of the system owner, as is likely to be the case with e-commerce sites. Although we may be unable to eradicate such difficulties, we are able to minimise the disruption they cause through the introduction of further functionality. If we are to provide solutions to the problems that the user experiences at the interface, arising from these temporal issues, then we must begin to give temporal issues higher priority than they are currently afforded in systems development. This is not to say that we should always try to incorporate strict temporal requirements, but that we must consider whether there are ways in we can reduce the impact on usability when delays and temporal inconsistencies are experienced.

3 Time and E-Commerce: Supporting the User

Temporal issues have a significant impact on the usability of Web-based applications. This is particularly important with regard to the dependability of systems used in e-commerce, where users will simply turn away if they experience delays when they attempt to use the services provided. If we fail to consider the user's experience in this kind of system, we are unlikely to build systems which are successful, either in terms of usability, or from a business viewpoint. It is however, important to note that, since Web-based applications rely on the use of open networks, their performance is not under the application owner's control. As delays may be caused by circumstances outside their control, it is meaningless to specify arbitrary temporal requirements (e.g. a web page should be fully loaded by a Web browser within 10 seconds of a user requesting the URL). With the best will in the world, there is currently no possibility that an application may be developed which could be shown to reliably meet that requirement. The alternative is to define requirements for system functionality which will allow users to deal with the inevitable delays.

As we stated above, the users temporal experience of e-commerce can be enhanced through both browser functionality and site design. In order to increase usability the browser is the more powerful tool, providing the user with the interface to e-commerce. If the user is to be provided with tools which provide support for user preferences it is here that we must start. However, no matter how powerful we can make the browser, site design will always impact upon the amount of time a user must spend in accessing services and cannot be ignored when we consider temporal aspects of usability for e-commerce. For the providers of e-commerce services this may be the only area in which they have control over temporal aspects of interaction. We consider site design first and then go on to illustrate ways in which the browser can be enhanced to provide support to users when uncontrollable delays occur.

3.1 Site Design, Time & Usability

There are a number of ways in which site design can impact upon the users temporal experience in e-commerce. In this section we highlight those factors which are most likely to cause the user delay, and which result in the user having to spend more time at a site than is needed, giving examples from well-know sites. We have found that when considering usability issues for e-commerce, site design and browser behaviour are tightly interwoven, and a number of issues could be approached from both angles. We believe that such issues are best approached in terms of the browser rather than site design. This is for purely practical reasons: the number of different browsers in use is small, and improved usability in this area could be experienced by users regardless of the site. In addition, many of the proposals we make aim to allow the user to input personal preferences. This must be done via the browser if the user is to see those preferences effected consistently, and such issues are therefore dealt with in section 3.2 below.

The notion of two-timing, discussed in section 2 above, requires that we consider the user's experience at the interface separately from hardware or performance issues. Site designers cannot simply assume that users have a particular level of hardware or network resources. They must take into account that many users, particularly those in

the developing world, have only slow and expensive access to the WWW, and that for such users, certain elements, such as large quantities of graphics, are simply unsuitable. Whilst we suggest adaptations to the browser to provide the user with the choice of filtering out graphics, the provision of text-only alternatives and the use of thumbnails greatly assist the user in reducing the amount of time spent accessing sites. Such provision increases the amount of control a user has over the time spent accessing sites, and allows them to use sites in a way that is more compatible with their particular system and preferences.

Site navigation plays a primary role in determining the amount of time which a user must spend at a particular site in order to achieve their goal, be it the purchase of goods and services, or the accessing of information. The well-known Amazon site, (http://www.amazon.co.uk) for example, provides a navigation bar that allows users to move around different sections with ease. In contrast, the Marks and Spencer site, (http://www.marks-and-spencer.co.uk) does not. In the Marks and Spencer site the user has no clear picture of where they are within the site and at times navigation is available only through judicious use of the browsers 'back' button. If a user gets 'lost' within a site, or finds it difficult to find what they are looking for, they will simply leave and go elsewhere. Therefore a successful e-commerce site must ensure that this does not happen.

Related to the concept of navigation is the logical design of the site. It is possible to provide sufficient navigation aids that allow a user to navigate a site despite poor logical design. This however requires the user always to invest time in using the navigation aids, as without them he is unable to navigate the site. If the site is designed consistently, with key buttons (such as one leading to the 'front' or 'home' page) always appearing in the same place on a page, a user will quickly learn his way around the site. Consequently, less time is used in navigation.

These issues all contribute to the amount of time which a user of e-commerce services must spend at a site in order to achieve their goal. If they are carefully considered when sites are designed, they can certainly enhance the user's experience at the interface, regardless of other temporal issues which may be beyond the control of the service provider. Web site design is a well researched area and there are a number of texts such as (Nielsen 99) which provide advice on effective design. The problem is not that we don't know how to design usable sites, but how we can persuade designers to adhere to the principles of effective design.

3.2 Browser Functionality, Time & Usability

There are two main sources for the browser functionality that we propose which is aimed at providing support to the user when temporal requirements cannot be met. The first is the literature relating to human computer action, and these ideas are presented in section 3.2.1. The second source is a study of compensatory actions taken by users presented with delays when accessing information on the WWW (McManus 97) and these are discussed in section 3.2.2. A summary of the additional functionality we propose is presented in section 3.3. We make our proposals in general terms rather than with reference to a specific Web browser. Where we are aware of the existence of similar functionality in a particular browser it is noted, but our intention is to focus

on the more general requirements for Web browsers which may be extrapolated for use in specific applications.

3.2.1 Sources of Requirements in the Literature

We noted above that rhythms may be easier to deal with than occasional delays, and so regularity may be of more relevance to the user's experience of time than actual response time (Dix 96a). In order to provide the user with a sense of rhythm the variability of response time must be reduced, this is discussed further in (Roast 98). Whilst it is clear that we would be unable to consistently meet some notional temporal requirement, for example that a page is always loaded within ten seconds, we can provide a sense of rhythm by ensuring that perhaps a dialogue is always commenced within this time, providing a range of alternative strategies in which the user might engage.

If the pace of interaction of web-based systems is too slow, the user's execution-evaluation loop will be broken, interrupting the interactive process. It has been noted that browser design suggests exploratory interaction with rapid feedback, whereby information is sought in an unstructured manner, following links and 'browsing'. The unpredictable delays experienced by users encourage more speculative and goal directed interaction (Roast 95) with users simply trying to find a particular piece of information as quickly as possible.

When using a Web browser the user is often presented with 'bizarre', apparently unpredictable temporal behaviour. This may be exacerbated by a lack of understanding of underlying network architectures. Interfaces often attempt to hide underlying system architectures and computations, but it may be that in the case of web browsers, this decreases rather than enhances usability. For example, two buttons which have the same appearance may lead to variously, a cached or remote page, which may take very different times to load. This could be overcome by allowing the buttons to be distinguished (Roast 95), providing the user with information which will assist him in determining whether he wishes to follow a particular path.

Johnson (Johnson 95) identifies a number of temporal issues that arise in interaction. One of these has particular relevance for networked or distributed systems, and therefore e-commerce sites: how may we provide users with an adequate representation of the flow of information from remote sites? This is a challenge which appears to have been taken on board in the Web browser Netscape, which gives a user some indication of the rate of progress. However, the fact that this information relates to the file currently under transfer renders this information meaningless to the user. The provision of information such as "45% of 117k" is insufficient for a user who is unaware of how many other files must be transferred. A more useful indication would be one which estimates how long it will take to transfer all files required to fully display the page.

A second area in which temporal challenges of interaction have been identified is that of multimedia systems (Johnson 95). Technological limitations, and particularly problems with speed of retrieval from remote sites, cause multimedia bottlenecks. This can have a considerable effect on the presentation of real-time media such as audio and video output. Real-time multimedia modalities are obviously tightly

interwoven, but it is suggested that as well as considering technological solutions (increasing processor speeds, shortening transfer times etc.) we should consider ways in which the user may exercise more power over the bottleneck, by choosing for example, to sacrifice some video quality, in order to gain enhanced sound quality, or vice versa. Consequently the user could indicate a preference for a particular perceptual modality. Thus two further issues identified are:

- how can designers represent the changing priorities that might be assigned to different modalities during interaction?
- how can these priorities be adequately related to the changing demands of particular user tasks?

This could be translated into a function which allows the user to sacrifice a particular modality on a page by page basis, without having to make permanent changes to the operation of the browser, as is currently the case for Internet Explorer. If delays are being experienced, a dialogue initiated by the browser, offering the user this, or other choices, would support the user in formulating the most appropriate strategy for his current needs.

The impact of retrieval delays on the value of information retrieved from remote sources has been considered in (Johnson 97). The author presents the results of a study which showed that the provision of information (such as the indication of the quality of an image shown via a thumbnail) at the interface meant that the user was better able to assess whether the cost of retrieving the information (in terms of the delay experienced), outweighed the value of that information. Consequently we make two further suggestions for the Web browser: Firstly, where possible, we should indicate the size of the file or page that links lead to (this information might be displayed when the mouse is moved over the link). Secondly, if the Browser were to initially render all images as thumbnails, providing the user with the option of displaying the full image on request, the user would have greater control over the time spent in retrieving images, and could thus choose to view only those which are of value to him.

Shneiderman (Shneiderman 87) argues that there are so many variables at play that it is impossible to define a single acceptable response rate. This conflicts with the suggestion in (Newman 97) that we need to define critical parameters for performance. Bearing in mind that short term memory decays after a few seconds, and that the acceptable response time for command line interfaces has been found to be 5 seconds, perhaps the imposition of a response rate (response does not necessarily imply full page loading) of this time would provide a starting point. In order to both provide the user with a sense of rhythm, and avoid the breaking of the execution-evaluation loop, we propose that within 5 seconds of the user requesting a particular URL, information is provided within the interface, estimating the time which it will take to fully load the page at current rates of transfer. However, given the varying expectations of different categories of users, and the disparities in performance of the systems being used it would seem sensible to allow the user to define the response time with the 5 seconds being used as a default.

In order to provide the user with greater control over the interface, and create a sense of rhythm which is adjustable to both the particular user and the system he is using, we also propose that the user is able to define a maximum acceptable loading time for Web pages. If this cannot be satisfied then the browser should commence a dialogue,

offering choices to the user as to how he wishes to proceed. For example the user may simply wish to record the URL so that he is able to remind himself that he wishes to return to the page, or alternatively he may decide that the page is of sufficient value that he is prepared to wait for longer than usual in order to view it. The options that we feel should be provided, based on both the discussion in this section, and the study presented in the next section, are presented below in section 3.3

3.2.2 Compensatory Actions Taken by Users

A study has shown that users will engage in a variety of compensatory actions in order to overcome difficulties presented by delays in accessing the WWW (McManus 97). These actions are of relevance to browser requirements, because they offer the opportunity to provide support for such strategies and minimise disruption experienced by the user when inevitable delays occur. Users take compensatory actions under two sets of circumstances:

1. The user has knowledge of the page location that he would like to reach and is trying to reach it as efficiently as possible. This is often combined with knowledge of the hardware and/or browser being used. The positive compensatory actions in these circumstances were:
- multi-threading (This can cause disorientation if the threads are similar, and cannot overcome the problem of slow network access)
- downloading pages to the local machine to look at later. (Users often found that graphics were not saved)
- expanding the cache, allowing for quicker access to pages viewed earlier in the session. As users can only remember 7 +/-2 chunks of information in the short term memory this allowed for forward and backward navigation without needing to revisit remote sites
- deactivating automatic image loading. This can be problematic if the author has not provided text alternatives.

2. Users do not know what information they are seeking, but wish to minimise the time spent in locating it. This resulted in the following actions:
- Using a site or author who the user feels has some credibility, following their links and maintaining contact with that site. However, user's views and understanding are not necessarily the same as those of the author
- avoiding sites which contain a large amount of graphics or which use frames
- using search engines
- use of personal information feedback or agents
- use of FTP instead

Not all of these compensatory actions can be supported by the Web-browser but they provide some insight into ways in which browsers may provide some support for the user in overcoming system delay. This support may be simply to provide the user with alternatives if delays are experienced, such as to open the page in a new window, or to save the URL in a location which will remind the user that he wished to view the page. Where a user strategy is currently problematic, such as the difficulties users have experienced with the saving of graphics, the browser could support the user by ensuring that he is able to save all of the relevant files.

3.3 Summary of Usability Enhancements to the Web Browser

Based on the discussion and survey in section 3.1 above, we propose the following usability enhancements to the web browser which will assist the user in overcoming delays encountered when accessing sites over the WWW. Where feasible we propose that functions should be user definable in order to support individual preferences.

1. That the user is provided with an estimate of the time which it will take to load the full page, based on total file size and current rate of transfer. This should occur within 5 seconds of the user requesting a particular URL. The time scale should be user definable with 5 seconds used as a default value
2. That the user should be able to define a maximum acceptable loading time (default value, 10 seconds) for pages to be fully displayed. If this cannot be satisfied an information box should be provided offering the choice of:
   - continuing to wait for the page to load
   - abandoning the request
   - loading the page into a new window
   - saving the page to a local disk for later viewing
   - disabling automatic image loading, or sacrificing audio transfer *(for this page only)*
3. A list of sites which the user wishes to view but has been unable to reach ('return- to's'), similar in style to bookmarks, should be incorporated in order to allow such pages to be remembered and filed
4. The location of a site (i.e. remote or cached) should be indicated through the use of distinguishable buttons
5. Indication of file and page size should be provided to allow the user to decide whether he wishes to view an image or linked URL
6. Where possible, indications of image quality should be provided using thumbnail images.

4 Conclusions and Directions for Future Work

If e-commerce is to perform according to expectations, usability is vital. A key factor of usability for e-commerce is the user's temporal experience at the interface. Although future technological developments promise ever faster speeds of data transfer, the current reality is that interaction over the WWW is often unsatisfactory in terms of temporal issues. We cannot afford to simply sit back and wait for the technological improvements which promise to make delays a distant memory, as users will find this simply unacceptable. Indeed if e-commerce brings the expected rise in users, it is likely that speeds over the WWW will deteriorate before we see any real improvement. Therefore we must look to ways in which we may alleviate the difficulties caused to users when the inevitable delays occur.

By considering the user's experience at the interface as a separate issue from the underlying performance of hardware and network architectures, we can consider ways in which usability may be enhanced despite temporal difficulties. We have shown that site design has a role to play in improving the user's temporal experience at the interface and suggested ways in which site designers can help to alleviate the problems caused by slow transfer speeds. However, we believe that, as the user's key

point of contact with e-commerce sites, the browser is the application which has the largest role to play in improving usability from a temporal point of view, particularly if individual user preferences are to be met. The web browser is the vehicle via which e-commerce is accessed, and just as a shopper without adequate transport will not visit an out of town shopping site, a user without an adequate browser will not use e-commerce services.

We have suggested a number of ways in which the functionality of the web browser may be enhanced, to provide support for user strategies which assist the user in overcoming difficulties caused by unavoidable delays. Where possible we have incorporated support for user preferences, which allows the user to tailor this support in order that it works best in conjunction with an individual user's hardware and level of experience. These additional functions should be seen as a starting point, but we must remember that as e-commerce progresses and the type of service it can offer evolves, further changes and functions will become necessary. It must also be noted that we have considered only the effect of time on the interactive process, and therefore the user support that we suggest is concerned only with temporal issues. There may be many other ways in which the browser may be adapted in order to enhance usability of e-commerce; further research is this area is certainly needed. However, in terms of temporal issues we believe that the approach which we have suggested, combining good site design with an enhanced browser, will certainly provide superior usability, supporting the successful development of e-commerce.

References

A Byrne
R Picking
Is Time Out to be the Big Issue?
Presented at Time and the Web, Staffordshire University
19 June 1997
Available at: http://www.soc.staffs.ac.uk/seminars/web97/papers/picking.html

A J Dix
The Myth of the Infinitely Fast Machine
People and Computers III
Diaper and Winder
CUP
1987

A J Dix
Pace and Interaction
People and Computers VII
Monk, Diaper and Harrison
CUP
1992

A J Dix
Que Sera Sera – The Problem of Future Perfect in Open and Cooperative Systems
People and Computers IX
Draper and Weir
CUP
1994(a)

A J Dix
Seven Years On, The Myth Continues
University of Huddersfield Research Report RR9405
1994(b)

A J Dix
Natural Time
CHI 96 Basic Research Symposium, Vancouver BC
April 1996(a)
Available at: http://www.soc.staffs.ac.uk/~cmtajd/papers/natural/natural.html

A J Dix
Temporal aspects of Usability: Delays and Temporal Incoherence due to Mediated Status-Status Mappings
SIGCHI Bulletin
Vol 28
3
April
1996(b)

A J Dix
D Ramduny
J Wilkinson
Interacting in the Large
Interacting with Computers, Special Issue on Temporal Aspects of Usability
1998

C Johnson
Time and the Web: Representing and Reasoning About Temporal Properties of Interaction with Distributed Systems
People and Computers X
M Kirby and A Dix
CUP
1995

C Johnson
What's the Web Worth? The Impact of Retrieval delays on the value of Distributed Information.
Presented at Time and the Web, Staffordshire University
19 June 1997
Available at: http://www.soc.staffs.ac.uk/seminars/web97/papers/

Lubars
C Potts
Richter
A Review of the State of Practice in Requirements Modelling
Proceedings IEEE International Symposium on Requirements Engineering, RE93
IEEE Press
2-14
1993

B McManus
Compensatory Actions for Time Delays
Presented at Time and the Web, Staffordshire University
19 June 1997
Available at: http://www.soc.staffs.ac.uk/seminars/web97/papers

W Newman
The Use of Critical Parameters in the Design of Web-Based Interactive Systems
Presented at Time and the Web, Staffordshire University
19 June 1997
Available at: http://www.soc.staffs.ac.uk/seminars/web97/papers

J Nielsen
Designing Web Usability: The Practice of Simplicity
New Riders Publishing
1999

H Parker

The Users Experience of Time During Interaction
Technical Report CRC-97-1, Computing Research Centre, School of Computing and Management Sciences, Sheffield Hallam University
Available at: http://homepages.shu.ac.uk/%7Ecmscrr/PAPERS/crc-97-1.ps.
1997

C Roast
Modelling Temporal Requirements for Interactive Behaviour
Proceedings of the International Symposium on Human Factors in Telecommunications
1995

C Roast
Designing for Delay in Interactive Information Retrieval
Interacting With Computers
10
87-104
1998

B Shneiderman
Response Time and Display Rate in Human Performance with Computers
ACM Computing Surveys
16
3
265-285
September
1984

B Shneiderman
Response Time and Display Rate
Designing the User Interface: Strategies for Effective Human Computer Interaction
Addison-Wesley
1987