Considering Disruptions in the Development of E-Commerce Sites

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Abstract

Developers of e-commerce applications are often unrealistic about the way in which their site will be used, and about possible outcomes during site usage. The most commonly considered outcomes of a user’s visit to a site are firstly that the visit culminates in a sale, and secondly that the user leaves the site without buying anything — perhaps to return later. In the second case, sites often ‘remember’ any accumulated items so that a shopper can return at a later stage to resume shopping.

In this paper we consider how disruptions to site usage could affect the outcome of the e-commerce shopping experience. These events have definite and possibly long-lasting effects on users, and applications should therefore be developed to cater for these eventualities so as to enhance the usability of the site and encourage further usage.

We develop a model for analysing e-commerce application usage and, using this model, propose an evaluation strategy for determining whether or not an e-commerce site will support recovery from disruptions. The proposed evaluation mechanism is applied to three sites to arrive at what we shall call a ‘disruption-resistance score’.

1 Introduction

Many researchers rate ease of use as being of critical importance to the E-Commerce(EC) process [24, 40, 43]. Poor usability is often blamed for the failure of sites [15, 35]. Liu et al. [21] found that the success of EC sites can be related to the quality of information they provide, system use, playfulness and system design quality — essential usability features. Usability can be tested in three ways:

1. asking users [40, 21, 18]. There are always problems with conducting user surveys because people do not always tell the truth.

2. scrutinising logs [36]. Logs are notoriously difficult to interpret [27] and such retrospective analysis may not be timely enough.

3. applying usability metrics. We argue here that this approach should be followed as a first step in ensuring usability of a site. In the case of EC sites, one usually has to publish the site and risk losing customers before problems become evident [8]. Tiernan et al. [39] emphasise the importance of first impressions to users. Kavanagh [17] cites a study which found that 80% of users fail to return to a site. To minimise the risk of losing users permanently due to poor usability, one should apply usability metrics and only then use a combination of the previous two methods to keep tabs on the usability of the site.

One aspect of EC sites which is not addressed in current research is that users can seldom use any system without being interrupted. Disruptions could be caused by errors, which could result from a breakdown in one of the systems involved in the distributed application, or from errors made by the user. Other external factors could disrupt users too. The user will often need assistance in recovering from these disruptions to their primary task.

Application developers routinely provide for recovery from human errors, often by means of informative messages. Applications seldom ease recovery from system breakdowns. It is rare for any application to actively support recovery from disruptions by assisting in the rebuilding of the user’s mental context. This paper proposes an evaluation mechanism to help designers develop web-sites which assist users in recovering from disruptive events. Before such a method-
ology can be provided it is necessary to understand the nature of the EC shopping experience, so this will be discussed first. The next section will explore EC user needs in the face of disruptions, and gives the results of an investigation carried out into the effects of disruptions on EC users. We then propose a disruption-resistance evaluation methodology for EC systems. The results of an evaluation which was conducted on three well-known EC sites are then given and conclusions drawn.

2 Analysis Of The E-Commerce Purchasing Experience

Researchers have examined the EC task from many different perspectives. We are interested in consumer behaviour because only by understanding human behaviour when interacting with EC systems can we determine the type of support which should be provided. Our previous analysis of the EC shopping experience can be consulted in [34] but we give a condensed version here for the sake of clarity. The purchase task of the EC shopping experience can be split up into two distinct phases, as shown in Figure 1:

1. **LSD — Look, See and Decide.** This is typically an iterative user-driven process with the following stages which can be traversed in varying sequences:
   - Welcome
   - Search
   - Browse
   - Choose

2. **Checkout.** This phase changes the paradigm of the interaction process from user initiative to system initiative and is typically composed of at least the following steps, which should be navigated in a serial fashion:
   - Buy
   - Back Out
   - User?
   - Where?
   - How?
   - Payment?
   - Sure?
   - Done

   (a) User? (b) Where? (c) How? (d) Payment? (e) Sure? (f) Done.

Many customers simply like to browse through the available products without necessarily buying each time they connect to a site [40] and enter the site at an arbitrary stage and leave before completing a transaction [10]. The ease with which they can leave a site and return later will affect their decision to proceed to the following stage [15].

3 E-Commerce User Needs In Recovering From Disruptions

When a user is busy with some activity, he or she builds up a *context* [6] — a rich mental environment that stores information built up during the time spent on using a particular system to execute some task. Even a momentary interruption will cause this mental context to collapse.

Disruptions inhibit performance in the execution of complex tasks [38] and increase user tension [41]. Concentration is broken if the same sensory channel is used by the disruption as is being used by the current task [19]. In the course of their activity computer application users are using their eyes, ears and touch senses (via their fingertips). They are also making heavy use of short-term memory. Thus computer users are less tolerant of an interruption than traditional workers because it disrupts their short-term memory and makes it hard for them to continue their task easily [3]. This intense use of the person’s cognitive abilities is in stark contrast to the traditional nature of the workplace where social interaction plays an important part in making up the person’s working day and often makes it more enjoyable.

The first step in dealing with a disruption is to decide whether or not to interrupt the current task. In the case of errors and breakdowns, the user may not have this choice, but certainly in the case of an environmental disruption or user-initiated interruption there is a choice. Disruptions will have an effect on the person’s attention and thus his or her performance.

Disruptions the user chooses to deal with will cause a delay between user actions and the feedback on these actions — so that the action and the observable effect will no longer be linked in the user’s mind [10]. Users tend to operate in terms of an *action-evaluation of effect-action* paradigm and once the time delay between action and observable effect is longer than the short-term memory span, the evaluation becomes difficult and decisions about the following action take longer.
Disruptions could come from various sources, as shown in Figure 2. The process of dealing with a disruption is directly dependent on its source:

- **task independent** — The user’s environment (P) is a rich source of disruption, including things like noise, overcrowding, isolation and user interaction with other users [1]. Users themselves disrupt task execution (I), perhaps because they do not want to wait for an application to complete a task and switch to another, because they have remembered an appointment or because of anxiety or insufficient confidence in their abilities [19]. End-user computers break down (F) causing a disruption of the user’s task. Other applications (OA) could also report an event which disrupts the user’s task with the EC application.

  The disruption has nothing to do with the current task and so the primary difficulty of dealing with it is that the user will need assistance in recovering context after the disruption.

- **task dependent** — Users err and sometimes make new errors when correcting errors (E) [1]. Often the application user interface causes the user to make errors (UI) [28]. A badly designed user interface could reflect organisational norms and mechanisms (O). EC application messages (M) which disrupt the user’s task could result from a breakdown in systems linked to the end-user’s computer, or from a user error. One can also see from the diagram in Figure 2 that many disruptions could cause an additional error (D), either due to the user’s handling of the disruption, or because the user’s concentration has been broken and attention diverted elsewhere (A). Once the task-dependent disruption has been dealt with, the user also has to recover context.

Dealing efficiently with both of the above types of disruptions thus requires some sort of memory aid so that users can easily resume their primary task after the disruption has been dealt with.

### 3.1 Recovery of Context after Disruptions

After a disruption has been dealt with, the user then needs to change context again and decide which task to proceed with. In some cases the user will resume the original task, but in 45% of cases, according to a study done by O’Conaill and Frohlich [30], the user will not resume the disrupted task, continuing with some other activity instead.

When people are doing paper work it is relatively simple to mark their current position so that they can return to it later [37]. In order for a computer system to support the user in the linearising of multiple activities, it is essential that the user be provided with some sort of memory aid. Users will benefit from some artifact which will support them in recovering the context of their pre-interruption activity or indeed some other activity which takes precedence. A mere list of the sites visited, as provided by most browsers, is too coarsely grained to be of much use, because users cannot be expected to remember the different web pages within the site — especially if the pages are dynamically generated.

The memory aid should keep the activity visible and provide a way for the user to ‘pick up the threads’ as quickly as possible upon resuming an activity. It is hard for applications to provide this facility effectively. Czerwinski et al. [7, 5] experimented with the provision of a marker to assist users to return to previous on-screen tasks but found that this did not assist users as much as expected. Harrison et al. [14] have experimented with semi-transparent windows in order to support the sharing of attention between different windows in an interface. Their report reports that they are still experimenting with levels of transparency and doing experiments to show that this mechanism does indeed help users to linearise various computer-based activities.

### 3.2 Survey Undertaken

We conducted a series of experiments to determine the effect of interruptions on users using EC sites. Researchers advocate different techniques for conducting research experiments [13, 4, 23]. For the purpose
of this study McMillan and Schumacher's [23] non-experimental research design has been used because it allows us to examine issues without suggesting a direct cause-and-effect relationship.

3.2.1 Experiment Description

The purpose of the experiment was to observe EC users' behaviour in recovering from interruptions. To this end, users were given a well-defined task and asked to complete it. They were interrupted during their task and then allowed to resume. Their behaviour was observed and findings recorded. A simple observation approach was used i.e. paper and pencil [9]. The passive observation research process [32] is the most commonly-used approach in the study of interactive systems, and parts of it have been adapted and used for this research\(^1\). The document given to the subjects is as follows:

You have just been given the keys an old Volkswagen Beetle. You have taken it upon yourself to service, modify and restore the Beetle.

You are required to go http://www.amazon.com (Amazon.com is an Internet based company that specialises in the selling of books). You have a sum of $100 to acquire books that would aid you in your task (this includes delivery costs). You should also ensure that the delivery period is less than a week. To aid you in your task please follow the following tips:

- Login to your machine
- Locate and launch the browser
- Type in the address/URL
- Find the books
- Add to shopping basket
- Proceed to purchase the books
- Proceed to checkout
- Choose to pay by cheque
- Review order but do not submit form
- End

The sample was selected using the systematic sampling technique [4]. In total 10 experiments were conducted, but only 9 responses were considered valid since one respondent chose to terminate the experiment before completion.

3.2.2 Findings

All subjects were interrupted for 5 to 10 minutes during the checkout phase of the task, and then asked to proceed with their task. It must be noted that not all subjects looked at the test administrator when they interrupted them — some subjects chose to look at the screen and conduct a conversation in that manner. The test administrator had to persuade the subjects to change visual focus.

The expert users recovered from the interruption in less than a minute and a half but the other subjects struggled to recover from the interruption, with recovery time ranging from 5.5 minutes to 15 minutes.

In the novice user group four subjects clicked on the 'back' button on the browser and retraced their path while the other three subjects chose to restart the entire process. No subjects scrolled down to the bottom of the page where Amazon.com provides a history of the user’s movement through the checkout phase.

An unexpected side-effect of the choice of topic is that the CAR tab proved a distraction to all the novice users. Subjects immediately, on entering the site, scanned the page looking for a word associated with the subject matter and clicked. On doing this a page on car sales was displayed as well as a pop-up window that tried to entice the user to purchase a wireless web cam. These windows proved to be a big distraction and subjects struggled to get back their flow of thought to proceed with the chosen task.

We have alluded to the disruptive effect of errors. During the experiment some error messages appeared and user responses to these were illuminating. One subject commented: 'I am an idiot' based on the error message “there is a problem with your order...”. Despite the subject trying to solve the problem, it seemed insurmountable. Messages to the users were cryptic, and users expressed their bewilderment by asking the administrator to interpret messages for them. One subject in the checkout phase received the message ‘can not find specific page’ and did not recover.

3.3 Disruptions in E-Commerce

The obvious conclusion which can be drawn from the findings in our experiment is that EC applications need to be designed with disruptions in mind so that the user's experience of using the application is sufficiently rewarding to encourage further use of the system. At any given time users need to know where they are, how they got there, what they can do and where they can go next [22]. Disruptions during the LSD phase are not dire if users can remember what they were searching for before the disruption. Disruptions during the checkout phase, however, could easily cost the EC site the sale [5].

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\(^1\) Passive observations occur when the researcher draws conclusions from information collected during interviews, from reports and by administering questionnaires.
The system designer can do two things to assist users in the face of disruptions — firstly minimize errors caused by a badly designed user interface (UI) and secondly, assist users in dealing with such disruptions as do occur.

It is our proposal that enhanced feedback be used to alleviate the problems users experience in dealing with disruptions. This feedback should have three functions: providing confirmation of current activities, explanations after errors and a sense of history so that users can easily resume their use of the application after a disruption.

We can categorise the type of feedback EC sites should provide under the following broad headings:

1. **Continuous** — in respect of things such as whether your last input was accepted, whether the system is busy processing your request, and so on. Supports system understanding by enhancing “observability” [42]. Attempts to minimise errors caused by UI in Figure 2.

2. **Explanatory** — in respect of errors or breakdowns, so that users know what their options are. This type of feedback supports error recovery [22, 42]. Attempts to facilitate the user’s processing of disruptions caused by E, F and UI in Figure 2.

3. **Historical** — what happened before the user arrived at this screen? Supports recovery of mental context after occurrence of disruptions indicated by I, E, P, OA, A and M in Figure 2 [33].

Feedback can be considered to be a planned interruption, generated for the purpose of avoiding task-dependent user-initiated or user-error disruptions or increasing the interpretability of the system. The feedback will increase the likelihood that the user will engage in an attentional mode of control, and take note of what is happening on the screen — and thereby reduce the need for error recovery at a later stage. A planned interruption does not disrupt the user’s context but rather serves to strengthen it.

4 **Mechanism For Testing Disruption-Resistance Of Sites**

The disruption-resistance requirements during the LSD phase are very different from those required in the checkout phase: The LSD phase is unstructured, iterative and information-intensive, and is characterised to a large extent by a situated-action paradigm of navigation. The user will react directly to what each search reveals, and according to some inner set of norms with regard to product preference and price. Disruption will break the situated-action searching process and the user may well not remember which search criteria had been used during the search process.

The user have to reorient his or her own mental context to repeat past actions. Most EC stores make use of a shopping basket and cookies in order to ensure that the basket is kept available over the lifetime of the cookie. Therefore, to a limited extent, they already cater for possible disruption during the LSD phase. A list of previous search criteria would go a long way towards helping the user pick up the threads if the breakdown occurs during the LSD phase.

The Checkout phase is system-driven, linear and requires far more inputs from the user. Disruption during this phase could cause users to give up and decide to purchase their products the traditional way. There is little support for disruptions during the checkout process. EC sites use browsers, and all browsers offer a ‘back’ button to allow users to check previous interactions with the system. However, using the ‘back’ button may change the state of the system, which is likely to have negative side-effects and affect transaction validity. Rather than relying on the back button, it would be better for the application explicitly to provide a history facility as part of its user interface and systems architecture.

Suitable elements have been selected from various evaluation methods [31, 12, 16] in order to set up a disruption-resistance evaluation mechanism, for each stage, that will help EC site developers to provide adequate support for recovery from disruptions. The evaluation criteria used were equally-weighted. In certain cases it may be advantageous to prioritize some of the criteria through a heavier, unequal, weighting. Examples of how to do this may be found in Levi and Conrad [20], Bastien and Scapin [2], the NCI Web site [25] and the World Wide Web Consortium Web site [44]. We prioritised by making a careful selection of criteria from the larger set of available metrics, and then using a binary weighting based on ‘good’ and ‘red-flag’ results.

The evaluation metrics for the LSD phase are shown in Table 1. The metrics for the checkout phase, given in Table 2, are somewhat different, reflecting the linear and structured nature of the checkout process.

In the following section we will describe how these metrics were applied to three EC sites and comment on the efficacy of the proposed evaluation mechanism. In order to evaluate EC web pages, a score is given for each of the above questions as follows:

- Never (0) — the feature is never available.
• Sometimes (1) — the feature is seldom there.
• Mostly (2) — the feature is usually there.
• Always (3) — the feature is universally available.

The scores are then determined per stage, and per site in the form of a percentage where 100% indicates a site giving a user perfect disruption-recovery support and sites with a low score should seriously consider remedial action. The scores per feature in each stage were calculated by adding up the score for each page making up the stage and awarding a total for each particular feature. The scores were then totalled to arrive at a percentage per site per purchasing phase.

5 Application Of Mechanism, And Evaluation Of Three Sites

We selected three sites, which sold similar products, to which the metrics would be applied. We chose Amazon (www.amazon.com) (the pioneers in this field), Books Online (www.uk.bol.com) and Kalahari (www.kalahari.net). We purchased various products from each EC site and evaluated the process using the tables given in the previous section. Our final scores for each site are given in Tables 1 and 2.

<table>
<thead>
<tr>
<th>Evaluation of Disruption-Resistance LSD Phase</th>
<th>Amaz max 9</th>
<th>Kal max 9</th>
<th>BOL max 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the system inform the user of the reasons for delays?</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Can the user easily undo a product selection?</td>
<td>9</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Does the system allow users to check on previous searches?</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Percentage</td>
<td>52%</td>
<td>33%</td>
<td>41%</td>
</tr>
</tbody>
</table>

Table 1: Evaluation Metrics for the LSD Phase

5.1 Discussion

A high score indicates that the developer has succeeded in providing adequate disruption-resistance for that particular feature of the site. One glaring problem, with respect to disruption resistance, is the lack of a facility to remind users of previous search criteria. Such a facility is as essential during the Checkout phase [18], but it is often not done consistently.

Dix [8] cites research which shows that people tend to wait 5 to 10 seconds for a web site to respond before

<table>
<thead>
<tr>
<th>Evaluation of Disruption-Resistance Checkout Phase</th>
<th>Amaz max 9</th>
<th>Kal max 9</th>
<th>BOL max 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the required format of user inputs clearly indicated?</td>
<td>15</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Is it clear what changes in the system have taken place as a result of a user action?</td>
<td>13</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Does the system inform the user of the success or failure of their actions?</td>
<td>14</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Does the system inform the user of the reasons for delays?</td>
<td>11</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Do error messages indicate:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What errors are?</td>
<td>12</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Where errors are?</td>
<td>6</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Why they have occurred?</td>
<td>6</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>What the user must do to recover?</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Is it clear what the user has to do to complete the task?</td>
<td>11</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Does the system indicate the current stage in the checkout process?</td>
<td>17</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Was information clearly available?</td>
<td>9</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Can the user easily back out of the process?</td>
<td>10</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Does the system ensure that the final purchase is confirmed by the user?</td>
<td>18</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Does the system allow users to check on inputs provided during the process?</td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Percentage</td>
<td>64%</td>
<td>55%</td>
<td>69%</td>
</tr>
</tbody>
</table>

Table 2: Evaluation Metrics for the Checkout Phase
feeling frustrated. Browsers regularly take at least this long to fetch a page. All browsers give observable feedback on page-fetch delays and anticipated completion times. However, many sites, including the ones evaluated, seem to rely completely on this facility rather than providing the user with some sort of site-specific indicator of site access (hit-rate). The user should be provided with an informative message if the response is going to take a long time.

A positive feature of all sites is the practice of sending a confirming email to users after a purchase — providing a sense of closure. With respect to enhanced feedback, Kalahari provides a summary of the user’s basket on all search pages.

BOL scored better than Amazon mainly due to its superior error-handling facilities. It also allows users to link directly to a customer service desk for online help. This is a smart move by BOL because an error-free completion of this phase is more likely to lead to a sale. Unfortunately BOL has not exploited its innovation very well because it restricts online help to daytime hours, and assumes that users will be in the same time zone by not explicitly linking their times to GMT. It is also unfortunate that BOL lapses into jargon when the online chat feature is activated.

6 Conclusion

In this paper the structure of the purchasing process of EC was investigated. We have identified two distinct phases during the shopping cycle and have applied stage-specific evaluation metrics to them. We have also investigated the types of disruptions users can experience during their EC shopping experience and have shown the interdependence of the disruption sources in Figure 2. The role of an enriched model of feedback to assist in alleviating the negative effects of disruptions during the EC experience was then explored. Such feedback would have to provide information about current EC application activity as well as a sense of the user’s past interaction with the EC application.

Nielsen [26] avers that the purpose of usability studies is to set the tone for a new design direction. Thus an evaluation mechanism was proposed which can be used by developers to analyze their sites so that problem areas can be identified and sites thereby made more resistant to disruptions. Similarly, for areas that perform well, even more of an effort should be made to maintain and improve the high standard.

References


