

Comparing the Effectiveness of Alternative Approaches for Displaying Edit-Error Messages in Web Forms¹ September 1, 2005

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Introduction

Many organizations routinely ask people to submit information via the Web. When entries are incomplete or questionable, the website can let users know what is wrong by using very simple visual cues such as the display of a graphic symbol by an item (for example, a red asterisk or a question mark) or the use of more detailed messages presented in a variety of formats. Regardless of the approach used, such checks are viewed as an important tool for improving the quality of data obtained in interactive Web forms, including self-completed survey forms (Anderson et al., 2003; Fox et al., 2004).

Designers of Web forms make the explicit assumption that the use of online edits will lead to higher quality data under the principle “get it right at the source.” However, usability testing of some Web survey applications at the Bureau of Labor Statistics (BLS) has revealed two problems with some edit messages used in survey instruments. First, some users never see the edit message when the screen refreshes, so they repeat the action they just took. Second, even when users do notice the edit message, they may not read or follow the instructions. On some commercial or government sites, an application might require that entries must meet certain criteria before the user is allowed to continue (defined as a hard edit). In other applications (for example, voluntary surveys), concerns that hard edits might frustrate the user, lead to increased burden, and even result in a user exiting a form without completing it encourage organizations to use soft edits. Soft edits warn users of a potential problem, but do not require them to make changes to an entry.

There are a variety of issues associated with the use of edits in Web survey forms. In many surveys, the Web is one of several reporting options (for example, mail, phone, and fax). Because the Web competes with other data-collection modes, in addition to the impact on data quality, it is important to consider the perceived burden among modes. Although edits can improve data quality, if overused, poorly designed, or confusing, they can also increase respondent burden and, therefore, have negative impacts on survey response or data quality.

In addition, it's not always clear when an edit should be used for maximum effectiveness. For example, should an edit appear immediately after an entry has been made, on a page-by-page basis (when a single page has multiple items), or at the very end of a multi-page form? Should the appearance of edits be determined by the programming logic, or

¹ The views and conclusions presented in this paper reflect the opinions of the author, and not the Bureau of Labor Statistics. The author thanks Stella Godbolt for assisting in data collection and Jean Fox for comments on early drafts of this paper.

should they be placed under the control of the user (for example, the user initiates edits by clicking a button)?

In addition to questions about timing and user control, edits can vary on a wide variety of design features. For example, any of the following features could be varied: font type, including size and color; location on the screen/page; the format of the message; use of graphical features (for example, a box, flashing, shading); use of a pop-up or completely separate window versus displaying the edit in the current window; use of a hard or soft edit; the wording of the edit message; use of multimedia; the presentation order of edit results (for example in the event of multiple edit failures on the same page, presenting edit messages one at a time versus all at once), and the sensitivity of an edit - for example, for numeric entries, how much of a deviation from an expected value must occur before the edit appears? If edits are too loose, data quality may suffer. If they are too stringent, respondent burden will increase.

Despite the widespread use, importance, and potential impact of edits on respondent burden, there has been very little research on factors that impact the effectiveness of edits. Instead, some papers have presented general design guidelines based on developer experience and observations conducted in usability studies (Murphy et al., 2001). Probably the most relevant of these suggestions for the current study is that edit messages should clearly identify the problem item (location), what the problem is, and what corrective action to take. Kanarek and Sedivi (1999) further suggest that instruments should present edit messages immediately after a questionable entry. Some other suggestions are that edit messages should be written clearly, use the active voice, and not confuse the user with multiple options (Anderson et al., 2003). Chatelaine (1998) argues that the text used in edit messages is important because in addition to providing guidance, it helps impart a personality to an application. She points out that users are more comfortable when they can figure out what a software's personality is, whether they like it or not.

The current study used an existing survey Web form (Survey of Occupational Injuries & Illnesses) and varied both the timing and location of edit messages to address the following research questions:

- Did the user notice edit messages?
- If noticed, was the correct action taken on the first attempt? On later attempts?
- Which approach for presenting edit messages was preferred by a user?
- Is there a correlation between a user's subjective ratings of overall form usability and performance on quantitative measures?

Based on observations in previous usability studies, it was hypothesized that in terms of the timing of an edit message, the most effective edit would appear immediately after a questionable entry. In terms of the location of the edit message, it was hypothesized that the most effective location would be directly beneath the item, since this would simplify the user's task when referring to the edit instructions and the entry that had been made. Therefore, it was further hypothesized that the most effective combination of design

factors would be to present the edit message under an item as soon as the user left the entry field.

Method

The Survey of Occupational Injuries & Illnesses (SOII) collects basic occupational information about a business, as well as detailed information about incidents involving worker accidents or injuries that lead to days of work being missed or reassignment of workers to a job with reduced work responsibilities. An existing 31-item survey Web form that used scrollable Web pages (Java server pages) was modified so that edit messages were displayed using one of three approaches. In all instances, when edit messages were displayed they were always visible on the screen without any scrolling being required. Three separate Web instruments were programmed to display the edit messages using the approaches described below.²

1. Approach 1. Edit messages were displayed toward the top of a page (under a standard screen banner and progress indicator), but only after **all** items on a page had been completed, and **after** the user clicked the *Continue* button. (see Attachment 1)
2. Approach 2. Edit messages were displayed **under** the item that triggered the edit, but only after **all** items on a page had been completed, and **after** the user clicked the *Continue* button. (see Attachment 2)
3. Approach 3. Edit messages were displayed directly **under** the item that triggered the edit, as soon as the user left the field and moved to the next item (it was not necessary to click *Continue*). (see Attachment 3)

The edit messages used in the three approaches were identical in appearance and size. They were presented in a text box and used red font that was slightly larger than the text on the form. The wording of the edit message itself was varied slightly to accommodate differences in instrument design, since after correcting an item in Approach 3, the participant was asked to move to the next item on the page rather than to click the *Continue* button. Only one approach was used in a given instrument. The edit messages varied as shown in the next table. The location of the edit message in the form was considered important because familiarity with the interface may affect how users react to an edit message. For this reason, edit messages were used that occurred in early and later sections of the instrument.

² A fully crossed factorial design would have required another condition where an edit message was displayed at the top of a page as soon as an entry had been made. Of the four approaches, this approach seemed least likely to be implemented in practice (the display of the edit message would be disorienting on a scrolling page). Therefore, it was not included to save programming resources. Examples of the screens and edit messages are shown in Attachments 1-3.

Table 1: Description of Edits Used in the Study

Edit	Location in Web Form (31 items on the form)	Soft or Hard	Occurrence	Type of Edit Instruction
1. “Total Hours Worked”	Item 2	Soft	Only edit on a page & in a scenario	Verify & re-enter entry
2. “Date of Injury”	Item 18 (on last page of form)	Hard	First of two edits on page	Match specified date format (mm/dd/yyyy)
3. “Age of Worker”	Item 23 (on last page of form)	Hard	Second of two edits on page	Enter new value according to instructions

Edit 1 asked the participant to verify and retype the entry and then click the *Continue* button to proceed. Edit 2 required that the date of injury be entered in a specific format (mm/dd/yyyy). For example, a common error was for the participant to leave off a leading zero for month or day (e.g., enter ‘9’ for September, instead of ‘09’). Edit 3 required the participant to enter a new value that was presented in the edit message. The first two edits are common in survey applications and were used in the production SOII instrument with minor wording differences.³ Edit 3 was a totally new edit and was not used in the actual survey form. It was included in this study solely to see what happened when participants were faced with more detailed instructions to read and follow.

Participants were recruited from a database of paid volunteers and selected for this study if they answered yes to the following two questions: Are you experienced with the Internet? Are you comfortable using a keyboard and mouse? Based on observation and the time required to complete the scenarios, participants reflected a wide range of characteristics and computer experience.

After the researcher covered the purpose and uses of the survey and gave a detailed, step-by-step explanation of how the paper form would be completed, each participant received a copy of the paper survey form with prefilled data (a scenario) and was asked to transfer the data to the Web form. The participants were asked to imagine that they worked for Company X, Y, or Z and their supervisor had just asked them to take a survey form she had just completed and to send the data to BLS using the online Web form. Since the forms were already filled out, this was essentially a data transcription task for the participants.

³ The wording of Edit 1 in the actual survey instrument was “Please confirm your entry.” Since an objective of the current study was to determine if a user would read and follow an edit instruction, this message was changed slightly to require re-entry of the value so that the activity could be observed.

Using a “talk aloud” procedure, the 42 paid participants completed a separate Web form for each of the three fictitious establishments. Each participant worked through the three scenarios in a single session, which lasted between 30-60 minutes. The appearance of an edit was controlled by the data being entered in a scenario, and participants did not know when an edit message would occur. Edit 1 always appeared by itself in a single scenario. Edits 2 and 3 always occurred together in a separate scenario, and were included to see how participants would react when two hard edits were encountered on the same Web page. A decision that designers face is what to do when more than one edit is triggered on the same page. For example, if both edits are triggered should the resulting messages be presented one at a time or all at once? To simplify programming in this study, the edit messages were presented one at a time, even if both edits were triggered on the same page.

The edit-presentation approach and edit appearances were counterbalanced across experimental sessions (see Attachment 4). Since a participant could encounter the same edit twice in an experimental session, in addition to different descriptive information for companies, different values of the key items (for example, hours worked, dates of injury, and employee ages) were used on the forms to reduce expected learning effects.

Participants were **not** told beforehand that an edit message would appear. This replicates the actual survey situation, where respondents enter data at their work site, and edit messages are triggered automatically by the system when a suspect entry is encountered. Since a talk-aloud procedure was used, it was usually clear through comments and by observing keyboard or mouse actions when participants saw an edit-error message. As a check of the procedure, if the soft edit message was missed in the third scenario, the researcher would wait until the participant progressed past the page on which the edit message appeared, then ask the person to back up to the relevant screen, and ask if she or he had seen the edit message.⁴ When this was done, all misses observed by the researcher were confirmed as true misses. With a hard edit, if there was any question an edit was missed, the experimenter would ask the participants if they saw the edit message on its first occurrence. To limit the length of the session, if a participant did not correct an entry after three attempts, the experimenter intervened and explained how to make the entry.

As noted, there were three separate scenarios: one for each of three different companies. To limit the expectation of receiving an edit, either the one soft edit (Edit 1) or the two hard edits (Edits 2 & 3) were triggered by the mock data being entered in a given scenario (the two hard edits appeared on the same scrollable Web page). But, Edit 1 and Edits 2 and 3 **never** appeared together in the same scenario. To reiterate, either Edit 1 appeared, or both Edits 2 & 3 were supposed to appear in a given scenario.⁵

⁴ This procedure was not followed when the soft edit appeared in the first two scenarios to avoid sensitizing participants to the presence of edit messages.

⁵ Some participants failed to trigger Edit 2 by not entering what appeared on the paper form. For example, the date might have been shown as 9/03/2003, but if they entered 09/03/2003, which was the proper format, the edit was not triggered.

Dependent Variables

The key dependent variables in this study were:

1. Edit message seen. Binomial variable (yes/no). Was an edit message noticed on its first appearance?
2. Success rate. Binomial variable (yes/no). Was the corrective action specified by the edit followed successfully?
3. Time for task completion. How long did it take the participant to complete the items on a page when an edit was noticed, and not noticed?
4. Preference rating. Which approach for presenting the edit messages was preferred?

To enable comparisons to be made between the soft edit (Edit 1) and the hard edits (Edits 2 & 3), only the participant's reaction to the first appearance of the edit was used since with the hard edits, the edit message would keep reappearing until the participant noticed it (or the experimenter intervened). As noted previously, it was usually clear from the "talk aloud" procedure and the participant's actions (for example, dragging the mouse across the words in an edit message) whether or not an edit message had been seen. And when the experimental procedure allowed it, as confirmation, the participant was asked to back up to the page with the edit message and asked if the edit message had been seen.

In terms of successfully following the instructions in an edit message, both the type of survey question and complexity of the edit instruction are important and are confounded in this study.

Since the soft edit always appeared very early in the form, there is also confounding in the experimental design between the type of edit used (soft or hard), the type of survey question, and the location of the item (and edit) in the form. However, since an actual survey form was used, and there was a logical order to the presentation of questions in the survey, it was decided not to attempt to systematically vary the location or type of edit used for different questions, since that would only have introduced another possible confounding variable.

Results

To reiterate, attention was focused on the first appearance of an edit message so that results could be compared between the soft and hard edits. As explained previously, if a participant missed the soft edit and clicked the *Continue* button, the next page (screen) of the form would appear.⁶ On the other hand, in the case of a hard edit, if the participant missed the initial appearance of the edit and clicked the *Continue* button, the edit message would continue to appear until the participant took the specified action or the experimenter intervened.

As shown in Table 2, participants missed the initial appearance of the soft edit message associated with the second question on the form (total hours worked) an average of 40

⁶ A user could back up to the previous screen, but this never happened.

percent of the time. Depending on the approach, the “miss rate” varied from 33 to 45 percent, but these differences were not statistically significant using a chi-square test (Pearson Chi-Square = 0.664, 2 df, $P < 0.717$).

Table 2: Proportion of Time Edits Were Missed by Edit-Presentation Approach (N is shown in parentheses)

	Edit		
	Total Hours	Date of Injury	Age of Worker
Approach 1	0.43 (21)	0.27 (15)*	0.05 (20)
Approach 2	0.33 (21)	0.23 (13)*	0.00 (19)
Approach 3	0.45 (20)	0.10 (10)*	0.18 (17)
<i>Overall</i>	0.40	0.21	0.07

* These n’s are smaller because some people entered the date using a format that did not trigger the edit.

The second edit, “date of injury” (hard edit), that appeared later in the form was missed an average of 21 percent of the time, with the miss rate ranging from 10 to 27 percent depending on the approach.

The third edit, “age of worker” (hard edit), appeared on the same Web page as Edit 2, and was missed an average of only seven percent of the time. In this case, the miss rate ranged between zero and 18 percent, depending on the approach. There were no statistically significant differences in initial miss rates among the three approaches used for the “date of injury” or “age of worker” edits (Pearson Chi-Square = 1.051, 2 df, $P < 0.591$ for ‘date of injury;’ and Pearson Chi-Square = 4.428, 2 df, $P < 0.109$ for ‘age of worker’). A logistic regression was run using the factors shown in Table 2 (approach and edit). In this analysis, the edit factor was statistically significant ($p < .000$), whereas, as in the separate chi-square tests, the approach was not significant ($p < .806$).

As shown in Table 3, even when participants saw an edit, a relatively large percentage of them failed to follow the instructions. For this analysis, the “success rate” was defined as taking the specified action on the **first attempt**, since the edit would keep reappearing for Edits 2 and 3 if the entry was not properly corrected.⁷

For Edit 1 (total hours worked), an average of 89 percent of the participants correctly followed the direction to verify and re-enter the value (range was 83 to 93). But, for the second and third edits, the percentage of participants correctly making the suggested change on the first attempt dropped to 72 percent for the date edit (range was 67 to 78), and to 76 percent for the age edit (range was 71 to 79). In the second and third edits, the instructions could be viewed as slightly more demanding than Edit 1, since Edit 2 required entering the date in a specific format, and Edit 3 required the participant to enter a specific value depending on the age entered in Edit 3. As in previous analyses,

⁷ Since Edit 1 was implemented as a soft edit, once users clicked the *Continue* key, the next screen would appear regardless of the correctness of their entry. Therefore, by definition, users had one attempt to correct Edit 1.

different approaches for presenting the edit messages did not result in statistically significant differences using chi-square tests.

Table 3: Success Rate When Participants Saw the Edit Message
(N is shown in parentheses)

	Edit		
	Total Hours	Date of Injury	Age of Worker
Approach 1	0.83 (12)	0.73 (11)	0.79 (19)
Approach 2	0.93 (14)	0.67 (9)	0.78 (18)
Approach 3	0.89 (9)	0.78 (9)	0.71 (14)
<i>Overall</i>	0.89	0.72	0.76

Table 4 looks at the overall effectiveness of an edit based on the total number of times it appeared (whether it was noticed or not) – specifically, it shows the proportion of the time that the correct edit action resulted. As shown in Table 4, depending on the edit and location in the form, the average success rate varied between 52 and 71 percent, where “success” is again defined as limited to the first attempt.

For the ‘total hours’ edit (Edit 1), the success rate barely exceeded half (52 percent). And, despite the fact that as shown in Table 2 the ‘date of injury’ edit was noticed 19 percent more of the time than the ‘total hours’ edit (0.40 vs. 0.21), the “success” rate of 57 percent in Table 4 changed little in comparison. The overall success rate for the ‘age of worker’ edit (Edit 3) improved to about 71 percent, but even here, almost 30 percent of the participants did not correctly follow the edit instruction on the first attempt.

Table 4: Success Rate Based On the Total Number of Times an Edit Message
Appeared *
(N is shown in parentheses)

	Edit		
	Total Hours	Date of Injury	Age of Worker
Approach 1	0.48 (21)	0.53 (15)	0.75 (20)
Approach 2	0.62 (21)	0.50 (12)	0.78 (18)
Approach 3	0.44 (18)	0.70 (10)	0.59 (17)
<i>Overall</i>	0.52	0.57	0.71

* The denominator includes all appearances of the edit, whether it was noticed or not.

Another question of interest was how did the different approaches compare in the amount of time spent dealing with the edit message? For example, how long did it take a participant to respond to an edit and move to the next page of the instrument? These data are shown in Table 5. Although timing data were collected for all edits, this analysis focuses only on Edit 1 because the times for Edits 2 and 3 were affected by their appearance on the same page, as well as the decision to focus on the first attempt for dealing with these hard edits.

The timer used for Edit 1 recorded the amount of time that expired between the time the participant first moved the cursor into the “Total Hours Worked” entry field, entries on this page were made, and when the *Continue* button was clicked to move to the next page (section) of the form. Since Edit 1 was a soft edit, clicking the *Continue* button would move the participant to the next page.

For Approaches 1 and 2, the *Continue* button always had to be clicked at least twice: the first click brought up the edit message, and the second click moved the participant to the next page. This was true whether or not the participant noticed the edit message. For Approach 3, however, the soft edit message was triggered when the participant moved to the next entry field (question), and when finished with the page, the participant could advance to the next page by clicking *Continue* only once.

Table 5: Time Required to Advance to the Next Page for the “Total Hours Worked” Edit

Group 1				Group 2			
If user saw message & took correct action				If user missed seeing message			
Approach	Mean (seconds)	sd	N	Approach	Mean (seconds)	sd	N
1	79.3	39.7	21	1	94.3	45.7	9
2	100.2	59.5	21	2	113.4	68.6	7
3	71.2	30.2	18	3	59.3	24.7	9
Overall	84.2				87.1		

For Edit 1 (total hours worked), the completion times for two separate groups were tabulated:

Group 1. Participants who noticed and responded successfully to the edit message.

Group 2. Participants who missed seeing the edit message and moved to the next page.

The time for Group 1 is of most interest, since an edit message is useless if it’s not noticed. Also, the time for the first group shows the effects of the design features under ideal conditions; that is, when the message is noticed, and a correct response results.

As one indicator of the wide range in skill level of the participants, the range of time required to notice the edit message and to take the correct action varied from a low of 36 seconds to a maximum of 232 seconds. And, contrary to expectations, participants who missed seeing Edit 1 took an average of 87.1 seconds to move to the next screen, whereas participants who both saw Edit 1 and completed the correct action, actually took less time; an average of 84.2 seconds. If time to complete this page, including the edit, is taken as a measure of proficiency, this finding suggests that computer proficiency or, possibly reading literacy, might be affecting performance. Unfortunately, neither of these variables was measured in this study. None of the timing differences shown in Table 5 is statistically significant.

At the conclusion of a session, participants were asked to rank order the three different edit-presentation approaches in terms of their preference (where 1 was most preferred, 2 next preferred, 3 least preferred). The average ratings were as follows:

Approach 2	1.67
Approach 3	1.85
Approach 1	2.46

Using the Wilcoxon signed ranks test, the differences between Approaches 1 and 2, and between Approaches 1 and 3, were statistically significant ($Z = -5.797$, $p < 0.000$; $Z = -6.682$, $P < 0.000$, respectively). However, the difference between Approaches 2 & 3 was not significant ($Z = -1.320$, $P < 0.187$). Therefore, participants expressed a clear preference for having the edit message appear under the item, but the timing of the message was not as important to them.

Participants were also asked to answer a few subjective questions at the end of the session about the general difficulty of entering data using the Web form. In response to a question that asked, “How easy or difficult it was it for you to enter the survey data?” participants reported that they found the task to be very easy. Their mean rating was 9 on a 10-point scale. Using the Pearson correlation coefficient, this subjective rating of usability correlated -0.313 with time to complete the first edit ($P < 0.05$, $n = 41$), but not with the number of times the first edit message was noticed ($r = 0.095$, $n = 41$).

Discussion

Contrary to expectations, varying the location and timing of the edit message did not have an impact on whether the edit message was noticed or, when noticed, if it was handled properly by the participant. However, this study demonstrated that when edits are used, especially a soft edit, they can be missed at a high rate. Less of a surprise, based on previous observations and usability studies, was the finding that participants often fail to initially follow instructions, even very simple instructions, displayed in edit messages. An anecdotal observation is that some participants, upon noticing an edit message, would begin to hypothesize what might be wrong, rather than read the edit message to find out what was wrong and how to fix it. For example, a participant might say, “Uh ... I guess it wants the date in this format, so let me try that,” or “I guess it wants a comma in the number.” Or, if a participant had entered the number with a comma, the participant might say, “I guess it doesn’t want a comma in the number, so let me take it out.” In some cases participants would first experiment with a variety of solutions and then read the edit message only as a last resort.

What might account for the high rate at which edit messages are missed? In the case of the soft edit used in this study, a likely explanation is that the edit came very early in the form before participants had a good chance to familiarize themselves with the interface and the general task. This conclusion seems supported by the much improved performance on edits that appear later in the form. So a “take home” lesson may be that soft edits should be used with care in the early part of an unfamiliar, interactive form.

Another, less obvious, cause may be a phenomenon known as “change blindness,” which is defined as the failure to detect what should be an obvious visual change in a visual field (McConkie and Currie, 1996; Rensink, O’Regan and Clark, 1997; Simon and Levin, 1997). This phenomenon appears to be a possible explanation, since the presentation of edits in this study meets the criteria for a condition described in the “change blindness” research as the “flicker effect.”⁸

What is the “flicker effect?” A necessary condition for change blindness to occur is that a change to a visual field must occur simultaneously with a disruption to visual continuity, such as during an eye saccade or a “flicker,” caused by the imposition of a blank screen, or, in the case of edit messages, the same screen being refreshed after a participant action. The screen reappears with the edit message, but participants fail to notice what seems to be an obvious change. During an experimental session, when a participant failed to notice the first appearance of the edit message, a typical response after clicking the *Continue* button might be, “Now why did this page appear again?” The participant would then scroll down the page and click *Continue* again. In fact, this is how the phenomenon was first noticed during usability studies when, what seemed to be very obvious edit messages, were missed by participants. When the edit message was pointed out by the researcher, a typical reaction was, “I didn’t see it, but I do now.”

Change blindness has been found to occur in a variety of situations (Varakin et al., 2004), and the use of edit messages on Web pages can now apparently be added to the list of examples. What causes this effect? The brain is very good at creating continuity in a visual field (for example, we all have blind spots in our visual fields that we never consciously notice), so when similar displays on computer screens change rapidly, differences may be subconsciously ignored by the brain. In fact, using theoretical arguments, Hudson (2001) warned that this effect might occur when using edit messages or search functions on websites. Although this is only a conjecture at this point, it is possible that the scrolling pages used in this study also contributed to the “change blindness” effect, since a significant screen reorientation occurred after the edit message was displayed.

With interactive Web forms there are at least two obvious solutions for reducing change blindness: use of a hard edit or presentation of the edit message on a separate screen (use of a pop-up window is another option, but this approach must deal with software “pop-up” blockers). If a hard edit is used, and navigation is prohibited, users will eventually see the edit message, especially when visual cues (graphics, color, different font) make the edit message more noticeable. Of course, as this study demonstrated, depending on the edit, a relatively large number of users might still not make the desired correction on the first attempt, or responding to the hard edit might lead them down undesirable paths in the instrument. For example, in response to the hard edits a small number of participants tried to use the help system to see why their entry was not accepted initially. Unfortunately, the help system was of no assistance in this situation and, in fact, led them down a futile, time-consuming path. As noted, another option would be to display the

⁸ For examples, see: <http://www.cs.bris.ac.uk/~cater/PhD/ChangeBlindInfo/Examples.html>

edit message on a completely separate screen, and then require the user to navigate back to the problem item to make the necessary correction. A criticism of this approach is that the user must retain relevant information in short-term memory to make the necessary correction. The use of a separate screen also increases programming difficulty and debugging, especially if a lot of edits are used.

A possible explanation for the higher rate of detection of the initial appearance of Edit 2 may be learning or increased expertise with the interface. In addition, by the time Edit 3 appears, participants are probably primed for it, since in the experimental situation, a hard edit occurred shortly before on the same page.

Another covariate that may be important, but which was not measured in this study, is the literacy skills of the participant. According to Nielsen (2005), lower-literacy users⁹ exhibit very different reading behaviors than higher-literacy users. For example, lower-literacy users tend to read word by word, take more time, and have a narrower field of view. If general reading and computer literacy are correlated, this might explain the results found in Table 5, where the group that saw and responded correctly to an edit actually took less time than the group that missed the edit (although the difference was not significant). Also, of potential importance to the results of this study, Nielsen claims that scrolling breaks lower-literacy users' visual concentration because they cannot use scanning to find the place they left off. On the other hand, higher literacy users tend to scan a page. However, it should be noted that these generalizations resulted from studying user behaviors on informational websites. There is some evidence that the behaviors required to complete an interactive survey form may differ from typical behaviors employed on a website, since the tasks and user expectations are different (Schober et al., 2003).

Users approach form-completion tasks on the Web with varying levels of motivation. In e-commerce sites, hard edits are commonly used because it can be assumed that users are motivated to complete the task. Also, businesses can't complete the transaction without correct information. So, once a hard edit appears, forward navigation is prohibited, and users must either fix the problem or abandon the form. In these situations, although "change blindness" might be important initially, it will eventually be overcome by most users as they scan or read a page to see what is wrong. However, in other form-completion tasks or applications, such as surveys that are completely voluntary, hard edits are generally not widely used because of concerns that perceived burden will increase and respondents will decide not to participate. In these cases, it seems highly likely that soft edits could be completely overlooked by a relatively large number of users, thereby leading to less improvement in data quality than anticipated.

⁹ One definition of lower literacy places readers at the 7th grade level or below, see http://www.worlded.org/us/health/docs/culture/intro_glossary.html

Although participants in this study expressed a clear preference for having edit messages displayed under an item, this location could cause problems for blind users who use screen readers and, therefore, might not satisfy the spirit of Section 508.¹⁰

The results of this study also advise caution when using subjective measures to assess usability. As noted previously, subjective measures of usability were collected in this study. This subjective rating of usability was found to correlate with time to complete a task, but it was not found to correlate with the frequency with which edit messages were noticed on their first appearance. This result reinforces the importance of collecting observational data when assessing usability.

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¹⁰ In 1998, Congress amended the Rehabilitation Act to require federal agencies to make their electronic and information technology accessible to people with disabilities. Federal agencies must give disabled employees and members of the public access to information that is comparable to the access provided to others.

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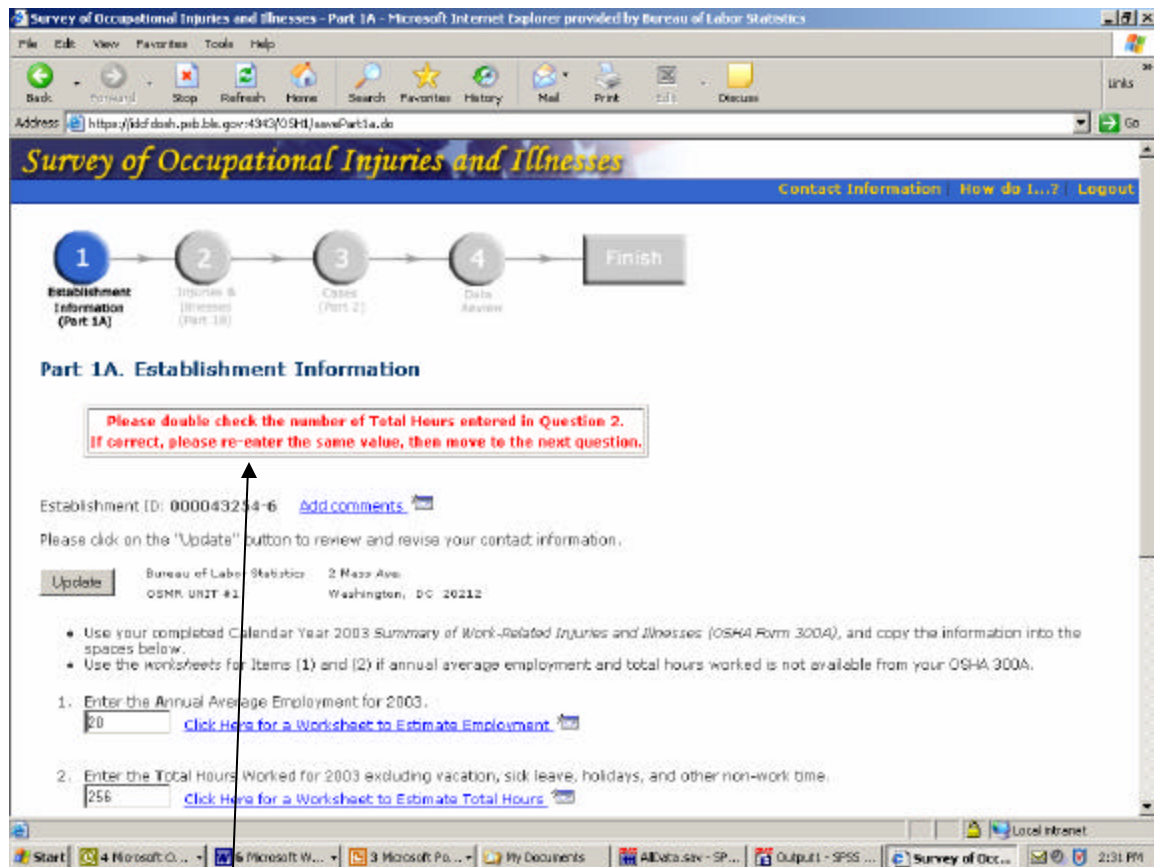
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Attachment 1 – Examples of edit messages displayed at top of screen

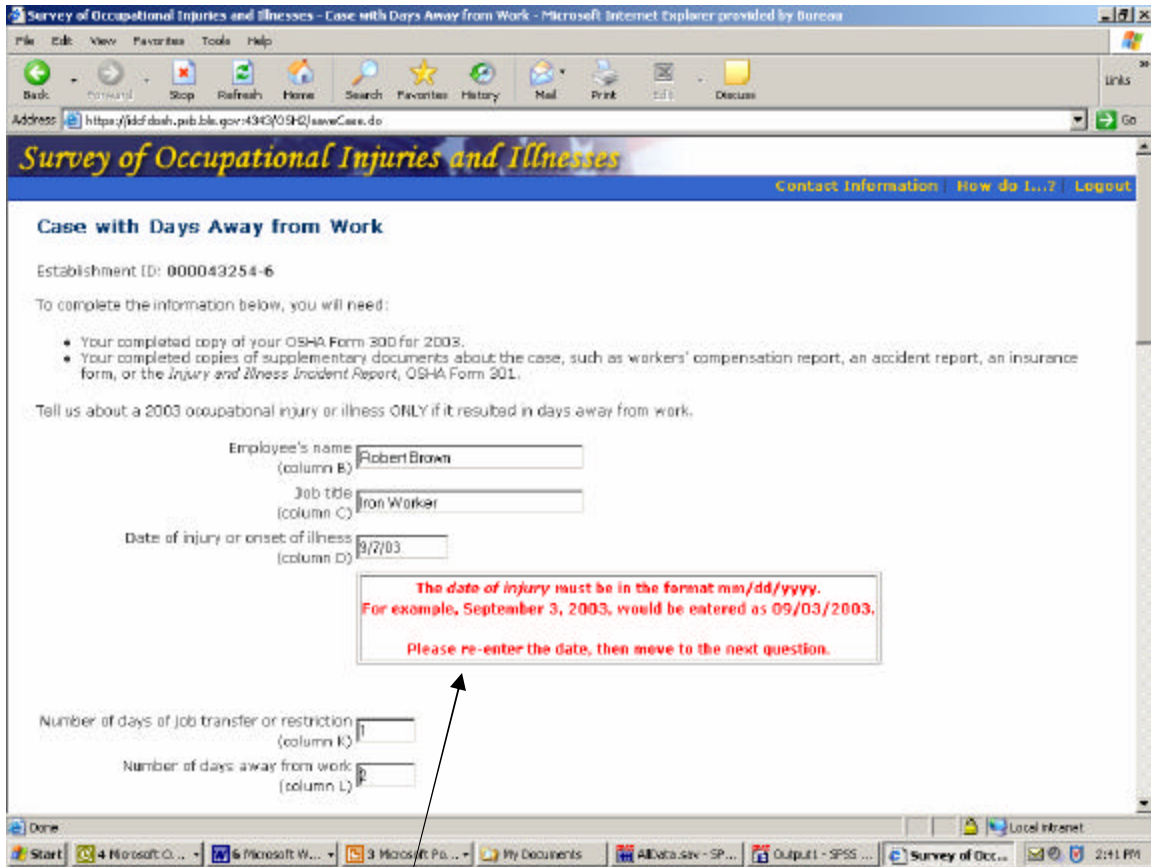
Edit 1 - “Total Hours Worked” Edit



Location of Edit Message in Approach 1
 (“Total Hours Worked” Edit)

Attachment 2 – Examples of edit messages displayed under item

Edit 2 - “Date of Injury” Edit



Location of Edit Message in Approaches 2 & 3
("Date of Injury" Edit)

Attachment 3 – Examples of edit messages displayed under item

Edit 3 - “Age of Worker” Edit

The screenshot shows a Microsoft Internet Explorer browser window displaying a survey titled "Survey of Occupational Injuries and Illnesses - Case with Days Away from Work". The address bar shows the URL: <https://idf.dosh.psb.state.pa.us/OSI2/awwCase.do>. The form contains several questions:

- Number of days of job transfer or restriction (column K):
- Number of days away from work (column L):
- 1. Check the category which best describes the employee's regular type of job or work: (optional)
 - Office, professional, business, or management staff
 - Sales
 - Product assembly, product manufacture
 - Repair, installation or service of machines, equipment
 - Construction
 - Other:
 - Healthcare
 - Delivery or driving
 - Food Service
 - Clearing, maintenance of building, grounds
 - Material handling (e.g. stocking, loading/unloading, moving, etc.)
 - Farming
- 2. Employee's race or ethnic background: (optional-check one or more)
 - American Indian or Alaska Native
 - Asian
 - Black or African American
 - Hispanic or Latino
 - Native Hawaiian or Other Pacific Islander
 - White
 - Not available
- 3. Employee's age: OR date of birth: (mm/dd/yyyy)
- 4. Employee's date hired: (mm/dd/yyyy)

An edit message is displayed in a red-bordered box:

**The Employee's Age in Question 3 is expected to be between 15 and 85.
Enter zero (0) if the age is less than 15, enter two zeros (00) if the age is more than 85.
Please re-enter the age, then move to the next question.**

An arrow points from the text "Location of Edit Message in Approaches 2 & 3 ('Age of Worker' Edit)" below to the edit message box.

Location of Edit Message in Approaches 2 & 3
("Age of Worker" Edit)

Attachment 4 – Counterbalancing of experimental conditions

Participant No. #	Approaches (1, 2, 3) & Edits (A1, A2, B1, B2)		
1	1A1	2B1	3A2
2	3B2	2A1	1B1
3	2A2	3B2	1A1
4	1B1	3A2	2B2
5	3A1	1B1	2A2
6	2B2	1A1	3B1
7	1A2	2B2	3A1
8	3B1	2A2	1B2
9	2A1	3B1	1A2
10	1B2	3A1	2B1
11	3A2	1B2	2A1
12	2B1	1A2	3B2
13	1A1	2B1	3A2
14	3B2	2A1	1B1
15	2A2	3B2	1A1
16	1B1	3A2	2B2
17	3A1	1B1	2A2
18	2B2	1A1	3B1
19	1A2	2B2	3A1
20	3B1	2A2	1B2
21	2A1	3B1	1A2
22	1B2	3A1	2B1
23	3A2	1B2	2A1
24	2B1	1A2	3B2
25	1A1	2B1	3A2
26	3B2	2A1	1B1
27	2A2	3B2	1A1
28	1B1	3A2	2B2
29	3A1	1B1	2A2
30	2B2	1A1	3B1
31	1A2	2B2	3A1
32	3B1	2A2	1B2
33	2A1	3B1	1A2
34	1B2	3A1	2B1
35	3A2	1B2	2A1
36	2B1	1A2	3B2
37	1A1	2B1	3A2
38	3B2	2A1	1B1
39	2A2	3B2	1A1
40	1B1	3A2	2B2
41	3A1	1B1	2A2
42	2B2	1A1	3B1

Explanation of Edits

- A “Total hours worked” edit (A1 and A2 are different values, depending on the scenario used)
- B Includes values for “Date of injury” and “Age of Worker” edits (B1 and B2 are different values, depending on the scenario used)

*Note: The number preceding A or B is the Approach number, where:

1. Approach 1. Edit messages were displayed toward the top of a page (under a standard screen banner and progress indicator), but only after **all** items on a page had been completed, and **after** the *Continue* button was clicked by the user. (see Attachment 1)
2. Approach 2. Edit messages were displayed **under** the item that triggered the edit, but only after **all** items on a page had been completed, and **after** the *Continue* button was clicked by the user. (see Attachment 2)
3. Approach 3. Edit messages were displayed directly **under** the item that triggered the edit, as soon as the user left the field and moved to the next item (it was not necessary to click *Continue*). (see Attachment 3)