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Information Technology Exception Messages: An Investigation of Compliance with the Normative Standards of Warnings

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1. Introduction

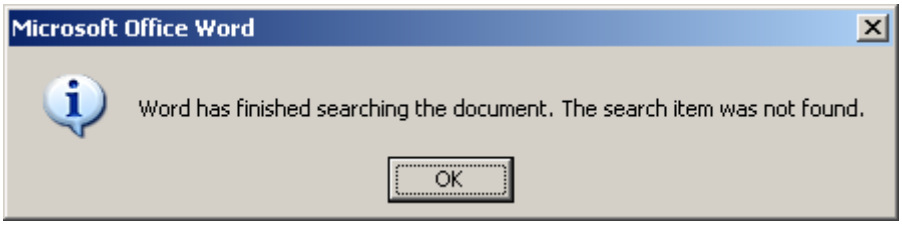
Users of information technology (IT) commonly encounter exception messages during their interactions with application programs. Exception messages, sometimes referred to as "dialogs," appear over the main window of the parent application program and engage the user by offering information and requesting some input (Cooper and Reimann 2003). When the user has finished viewing or changing the information presented, he has the option of accepting or rejecting his changes. The exception message then disappears and returns the user to the main application program.

A common type of exception message is the "bulletin box." A bulletin is launched by the program, not the user. This type of exception message stops all progress in the main application, and is sometimes called a "blocking bulletin" because the program cannot continue until the user responds. There are three categories of bulletin exception messages with an example of each illustrated in Figure 1 (Cooper and Reimann 2003): (1) error messages inform the user of a problem or potential problem, (2) alerts (a.k.a. notifiers) give notice to the user of the program's action, and (3) confirmations notify the user of the program's action and gives the user the authority to override that action.

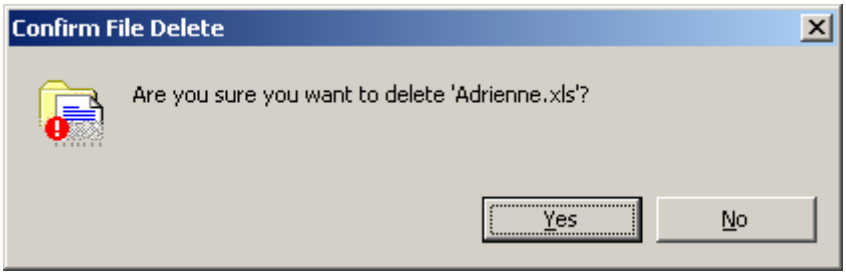
Figure 1. Examples of the Three Types of Bulletin Exception Messages

a. Error Message:

b. Alert (a.k.a. notifier):



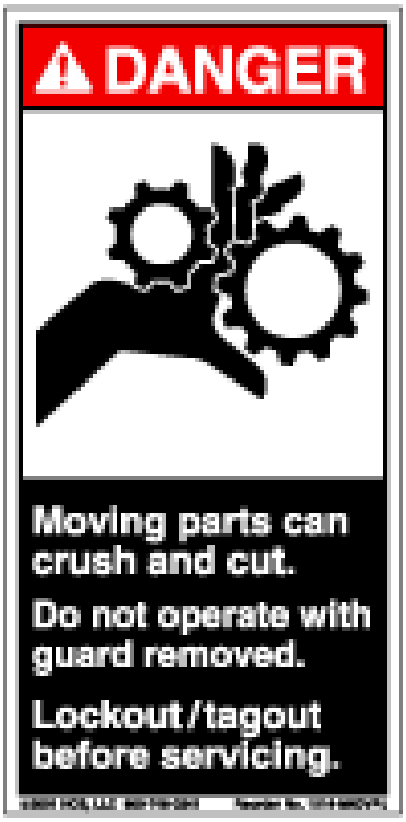
c. Confirmation:



Bulletins are similar in purpose to the warning messages that appear on consumer products and equipment, in various work and life situations, and on chemicals. Both bulletins and warning messages are designed to inform people of problems or actions required to be taken. For example, warnings appear on household cleaners and ladders to inform the user of a problem if the item is inappropriately used. Likewise, warnings appear in various environments to notify and advise people in the correct use of equipment and of potential hazards. Two examples of

such warnings are shown in Figure 2. Considerable research has been targeted on the content of warnings to determine the effect on human perceptions, judgment and decision making (see Wogalter 2006a). This research has resulted in normative guidelines specifying the elements and information that should be included in warning messages. Including these elements improves the informativeness of these messages.

Figure 2. Examples of Warnings used in Work Environments



The primary objective of this manuscript is to review the normative elements and information that are included in product, chemical, and environment warnings and to propose that these elements and information should also be included in IT exception messages. Doing so, will increase the effectiveness, informativeness, and consistency of exception messages. A secondary objective of this manuscript is to present an analysis of a sample of IT exception messages to measure their compliance with the normative standards of warnings. Results indicate that IT exception messages lack descriptive content relative to normative prescriptions established in the literature on warnings.

2. Elements of Well Designed Warnings

Generally, the warnings literature suggests that a well designed warning should contain two key sections or "panels" (Wogalter 2006b and Wogalter et al. 2002), a signal word panel and a message panel. The two warnings of Figure 2 each possess these two panels and each panel has a specific purpose or function.

The purpose of the signal word is to draw the user's attention and to express a level of hazard or probability of injury associated with the environment or situation. The signal word panel itself is to contain three elements: (1) a signal word, (2) color coding, and (3), a signal icon. Note that the signal word in the first warning of Figure 2 is "DANGER" and in the second, "WARNING." The color coding in the first is red and orange in the second. Finally, both warnings in Figure 2 contain the signal icon in the form of an exclamation point in a triangle. Research findings and the American National Standards Institute (ANSI 2002) have identified suitable sets of signal words and signal icons to be included in this panel of a warning.

The purpose of the message panel is to convey specific information about the hazard or situation. This information can be expressed using language, using symbols or by using both language and symbols. While both the warnings in Figure 2 contain a symbol, this is generally considered an optional feature of a well-designed warning. The language and/or symbol of the message panel should communicate three informational elements: (1) identification of the hazard, (2) explanation of the consequences of the hazard, and (3) directions as to how to avoid the hazard.

The three informational items in the message panel should be as explicit and as complete as possible. Consider the first warning of Figure 2. The hazard is specifically noted as "Moving parts…" The consequence of the hazard is illustrated by the mangling of the hand in the symbol as well as by the language in the panel: "…can crush and cut." Finally, the language also provides directions on how to avoid the hazard: "Do not operate with guard removed" and "Lockout/tagout before servicing."

Taken together, the elements of a well-designed warning would seem to be very appropriate for IT exception messages, especially bulletins. An examination of the three bulletins of Figure 1 shows deficiencies relative to the prescriptions described above for warnings. Indeed, the error message of Figure 1a. is especially lacking in information content. Of course not all IT exception messages are deficient, but there is a lack of prescriptive guidance in both academic and professional IT guidelines as to the content of exception messages.

3. Guidance in the IT Literature

On the academic side, Amer and Maris (forthcoming) examined and measured the "arousal strength" (i.e., the perceived severity of hazard a warning communicates) of the common signal words and signal icons used in IT exception messages. The data captured allows exception messages to be designed to communicate different levels of hazard in order to achieve so called "hazard matching." Hazard matching occurs when the severity of the hazard that is implied by the signal word and icon within the exception message matches the level of hazard faced by the user. One objective of their research was to provide system designers with data that will allow them to improve the informativeness of exception messages by achieving hazard matching.

The professional literature and researchers in human computer interaction (HCI) offer limited guidance as to the content of exception messages. Apple Corporation (1989) notes that some icons that appear in exception messages have "standard accepted uses" (p.115). These icons are "right and left arrows, return arrow, About box balloon, check box, radio button, and the house icon" (p.115). However, only ambiguous advice is given as to how these elements should be used: "Any button in one of these shapes must conform to the expected use, or users will be confused" (p.115). Little is offered with respect to the informational content of exception messages.

Microsoft, in ***The Official Guidelines for User Interface Developers and Designers*** (***UI Guidelines:*** Windows XP Design Team 2001) contains more specific guidance for the components of what they term "message boxes." The UI Guidelines provide recommendations for the following components of message boxes: (1) title bar text, (2) use of icons, and (3) message box text. The general view of the Microsoft UI Guidelines is that the title bar identifies the source of the message, the icon identifies the type of message, and the text presents the message. Little other guidance regarding the form and content of exception messages is offered.

It is interesting to note that Microsoft in the UI Guidelines implies that no additional information is communicated by combining signal words and signal icons. The implication is that only one of these elements should be included in an exception message. Amer and Maris (forthcoming) when measuring the arousal strength of exception messages containing both signal icons and signal words found that combinations of the two increased the perceived severity of hazard communicated. Microsoft's implication seems to be false in the context of arousal strength.

Cooper and Reimann (2003) believe that bulletin exception messages are abused by systems programmers and should be eliminated if possible. If bulletins are to be used, Cooper and Reimann offer some guidance on key design features such as including a title bar, minimizing the size of the message window, and offering terminating commands. With respect to error messages, Cooper and Reimann advise that a well-formed message should be polite, illuminating, and helpful. In addition, they indicate that an error message should give the user the information he needs to solve the problem, make clear the scope of the problem, the alternatives available, and offer to take care of the problem. This advice corresponds to that noted above by warnings researchers who specify that the message panel of a warning should communicate: (1) the identification of the hazard, (2) an explanation of the consequences of the hazard, and (3) directions as to how to avoid the hazard.

Shneidermann and Plaisant (2005) note that dialogs and error messages should provide informative feedback. In addition, error messages should offer specific information about the nature of the problem, and indicate what the user needs to do. Error messages should also provide simple, constructive, and specific instructions for error recovery. As with Cooper and Reimann, the recommendations of Shneiderman and Plaisant align with that of the researchers in warnings.

4. Proposed Elements of Effective Exception Messages

Combining the guidelines established in the warnings literature with the recommendations provided by the IT authors Cooper and Reimann and Shneiderman and Plaisant leads to a set of normative elements that, arguably, should be possessed by IT exception messages. The following five elements are proposed:

1. **Signal word and/or Icon:** An exception message should include an appropriate signal word and/or icon to catch the attention of the user. The signal word/icon combination should arouse the user to a level that matches the nature of the underlying hazard.
2. **Hazard Information** (illuminate the problem): An exception message should inform the user what the problem is.
3. **Instructions**: An exception message should instruct the user about what to do or not do.
4. **Consequences** (alternatives): An exception message should inform the user as to what will result from all the actions taken or from inaction.
5. **Offer a Solution**: An exception message should offer to implement at least one solution itself, without requiring the user to take unreasonable action.

It seems reasonable that IT exception messages should contain all the above elements to improve their informativeness, consistency, and effectiveness. Establishing such standards for the form and content of exception messages is consistent with the views expressed in the academic and professional literature in IT. Blackwell and Green (2003) note that presenting similar information in different ways compromises usability. Shneiderman and Plaisant (2005) state the need for consistency, conventions, and guidelines in the design of interfaces in general, and for effective exception messages in particular. The first of their eight “golden rules” of interface design is “strive for consistency.” Likewise, consistency and standards in interface design are noted by Cooper and Reimann (2003).

If it is agreed that IT exception messages should contain the above elements to improve their informativeness, consistency, and effectiveness, then a reasonable question to ask is “How do existing exception messages compare to the normative prescriptions?” If deficiencies in the current state of IT exception messages are found to exist, then systems programmers can target their efforts to begin improving exception message design. To this end, the following section describes an evaluation of a sample of exception messages.

5. Method

The authors collected a sample of exception messages that each encountered over a two month period during normal computing interactions. Each time the authors encountered a unique exception message, a screen shot of the message was saved to a database. The types of interactions and application programs utilized during this period included e-mail, word processing, spreadsheet implementations, Internet interactions, etc. Given that the authors’ university computing standard is Microsoft, nearly all the exception messages captured were displayed by Microsoft products or Windows-based applications. In total, 120 unique exception messages were collected by the authors over the two month period. All three types of exception messages – error messages (51 occurrences), alerts (a.k.a., notifiers – 16 occurrences), and confirmations (53 occurrences) – were included in the sample. Examples of the types of messages collected are shown in Figure 1.

It is noted that the sample of exception messages collected by the authors is certainly not a random one, and is obviously skewed toward Microsoft related applications. However, as a first attempt to evaluate the content of exception messages the sample does offer useful insights as to the information contained in exception messages and how that information conforms to the five normative elements noted in the prior section of this manuscript.

Each exception message in the database was then evaluated independently by the two authors to determine if the message contained the five elements introduced above. After evaluating all 120 exception messages independently the two evaluators convened to discuss any differences in the resulting scores. Where differences occurred between the evaluators, the individual exception message was examined and reevaluated so that a consensus as to the presence of the element was determined.

6. Results

Table 1 provides a list of the number and percentage of exception messages that contain each of the five elements. For example, 82.5% (99) of the 120 exception messages contained a signal word and/or signal icon. Likewise, 80.8% (97) of the 120 messages contain information regarding hazard information. That is, information that informs the user of the problem they are facing. The compliance percentage drops from there with only 22.5% of the messages listing the consequences of what will happen or not happen as a result of actions taken by the user. Additionally, only 24.2% of the messages provide information about possible solutions or offer to implement a solution.

Table 1. Exception Message Conformance with the Five Normative Elements (%) – Sample of 120 Exception Messages

Normative Element	*Count*	*Percentage*
1. Signal word and/or Icon	**99**	**82.5**
2. Hazard Information	**97**	**80.8**
3. Instructions	**81**	**67.5**
4. Consequences	**27**	**22.5**
5. Offer a Solution	**29**	**24.2**

Overall, the sample of exception messages examined for this study is deficient in itsr informativeness with respect to the application of the normative elements set forth in this manuscript. Indeed, less than 6% (7 of 120) of the messages in the sample collected contained all five elements. This result seems especially disturbing in that exception messages occur at the very point in a user's interaction where the most information possible should be offered by the system. Additionally, incorporating the proposed elements to exception messages could be accomplished relatively easily in IT environments when compared to other situations (e.g., consumer product warning labels) given the ability to easily alter the display of information on a computer screen.

6.1 Signal Words and Signal Icons Together

As noted above 82.5% (99) of the 120 exception messages contained a signal word ***AND/OR*** signal icon. Further examination of the sample reveals that most contain a signal icon, but few contain signal words. Eighty percent of the messages contain a signal icon of some form whereas only 14.2% contain a signal word. It seems that most systems designers do follow Microsoft's suggestion and include signal icons but not signal words in exception messages. In fact, only 10.8% (13 of the 120 messages) contained ***BOTH*** a signal word and signal icon.

6.2 Error Messages, Alerts, and Confirmations

Table 2 displays the percentage of exception messages that contain each of the five elements by type of message: error messages, alerts, and confirmations. Two interesting results are noted. First, of the alerts in the sample, none contained the fifth proposed element: **Offer a Solution** (i.e., an exception message should offer to implement at least one solution itself, without requiring the user to take unreasonable action). This outcome is not surprising given the purpose of alerts within the IT environment. As noted above, alerts give notice to the user of the program's action. Accordingly, one would not expect an alert to offer a solution when its purpose is to inform the user of the action being taken.

Table 2. Error Messages, Alerts, and Confirmations – Percentage Conformance with the Five Normative Elements

Normative Element	*Error Messages*	*Alerts*	*Confirmations*
1. Signal word and/or Icon	**82.4%**	**93.8%**	**83.0%**
2. Hazard Information	**86.3%**	**56.3%**	**83.0%**
3. Instructions	**68.6%**	**43.8%**	**73.6%**
4. Consequences	**5.9%**	**18.8%**	**39.6%**
5. Offer a Solution	**21.6%**	**0.0%**	**34.0%**

The second result illustrated by the percentages of Table 2 is more surprising. Only 5.9% of error messages in the sample contained the fourth proposed element: **Consequences** (i.e., an exception message should inform the user as to what will result from all the actions taken or from inaction). This is somewhat unsettling given that the purpose of error messages is to inform the user of a problem or potential problem. To not provide information as to the consequences of the actions taken or not taken to the user who receives an error message seems especially troubling. Arguably, it is at the juncture where a user receives an error message that the system should provide the most information possible, especially the consequences of the actions that may be taken by the user.

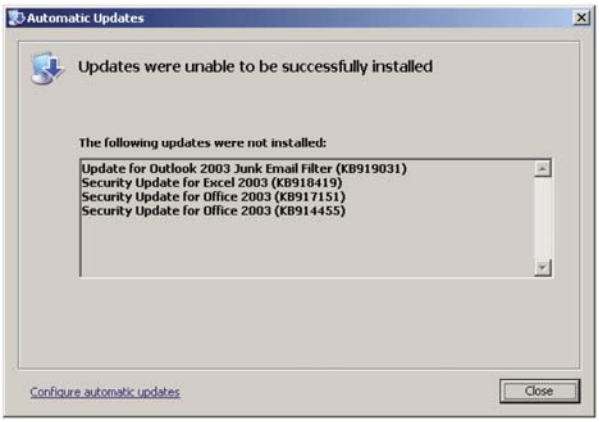
6.3 Examples of Poor Exception Messages

Several especially poor exception messages within the sample were identified by the authors. These messages were deficient across most of the five normative elements and a simple examination of the messages makes obvious their lack of informativeness. Three such messages are illustrated in Figure 3.

Figure 3. Examples of Poor Exception Messages

The following message was displayed during the installation of Microsoft Outlook:

The following message was received during the automatic update process for Microsoft Windows:

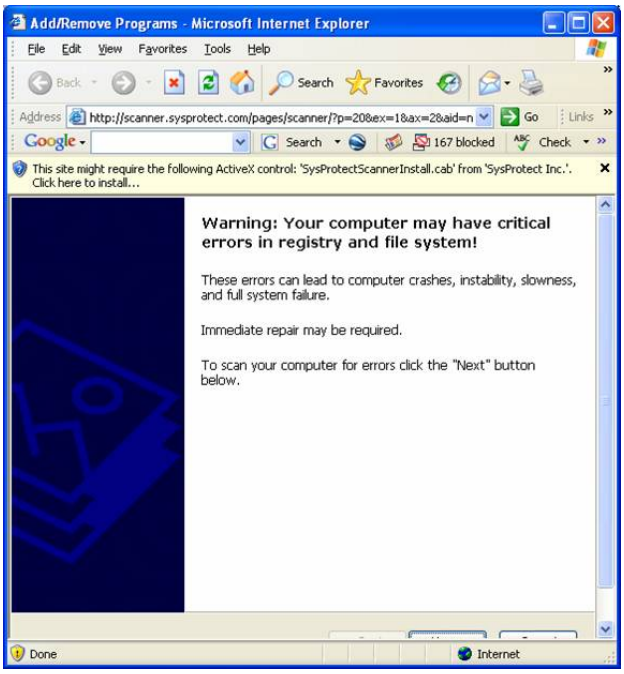


6.4 Examples of Good Exception Messages

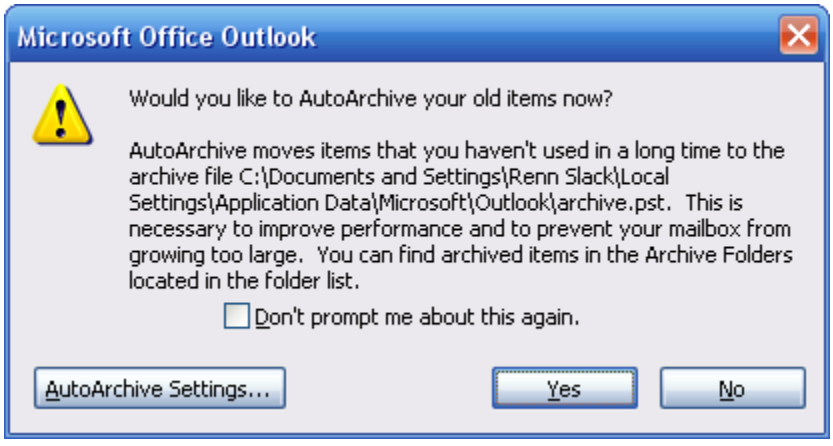
Good exception messages were also captured. These messages contained nearly all of the normative elements and provide the user with an informative interaction. Three such messages are illustrated in Figure 4.

Figure 4
Examples of Good Exception Messages

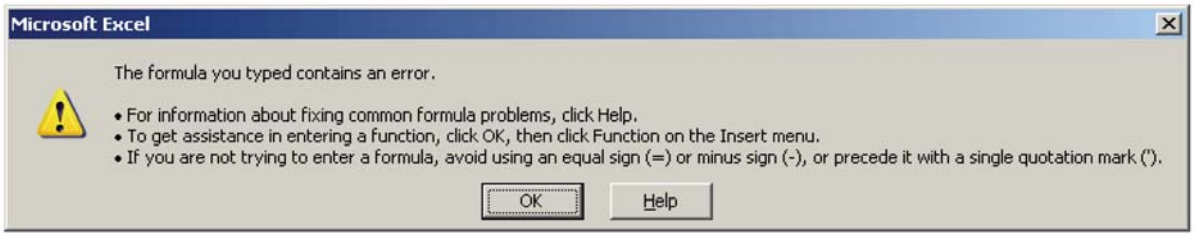
The following message was displayed by Windows IE while moving from one page to another:



The following message was displayed during a Microsoft Outlook session:



The following message was displayed after erroneously entering a formula in Microsoft Excel:



7. Discussion and Conclusions

This manuscript reviews the normative elements and information that are included in product, chemical, and environment warnings and, in conjunction with some guidance provided in the IT literature, proposes that these five key elements and information should also be included in IT exception messages. A sample of exception messages that included error messages, alerts, and confirmations was then examined to determine their conformance with the normative elements proposed. Results of that examination indicated that, in general, most exception messages in the sample lack informativeness in that they are deficient in the normative elements. The effectiveness, informativeness, and consistency of exception messages could be improved if systems designers and application programmers incorporate these elements in exception messages.

Of special note is that exception messages lack information regarding the consequences of the computing situation. That is, there is little information provided to the user as to what will result from all the actions taken or from inaction. This was especially true of error messages – A deficiency which is particularly noteworthy given that the purpose of error messages is to inform the user of a problem or potential problem. Of the three types of exception messages, error messages should provide information to the user as to the consequences of the actions taken or not taken.

Additionally, few exception messages offer to implement at least one solution itself, without requiring the user to take unreasonable action. In user-centric computing environments exception messages should provide as much information as possible and should provide as much assistance to users as is practicable. Indeed, incorporating the proposed elements and information in exception messages could be accomplished relatively easily in IT environments when compared to other situations (e.g., consumer product warning labels) given the ability to easily alter the display of information on a computer screen.

Future research should examine larger samples of messages and messages from other computing platforms such as the Apple, Linux, and Unix operating systems. Additionally, research could explore how these deficiencies may influence user's perceptions, judgments, and decision making. Those deficiencies that are demonstrated to negatively affect users should be the first to be addressed by systems designers and engineers. This study provides a first step in that direction.

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