

User Frustration with Technology in the Workplace

Jonathan Lazar¹, Adam Jones¹, Katie Bessiere², Irina Ceaparu³, and Ben Shneiderman³

¹Department of Computer and Information Sciences,
Center for Applied Information Technology, & Universal Usability Laboratory
Towson University, Towson, Maryland, 21252

²Human-Computer Interaction Institute
Carnegie-Mellon University
Pittsburgh, Pennsylvania 15213

³Department of Computer Science, Human-Computer Interaction Laboratory,
Institute for Advanced Computer Studies & Institute for Systems Research
University of Maryland, College Park, Maryland 20742

E-mail: jlazar@towson.edu; ajones5@towson.edu; katieb@cmu.edu; irina@cs.umd.edu;
ben@cs.umd.edu

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Abstract

When hard to use computers cause users to become frustrated, it can affect workplace productivity, user mood, and interactions with other co-workers. Previous research has examined the frustration that graduate students and their families face in using computers. To learn more about the causes and effects of user frustration with computers in the workplace, we collected modified time diaries from 50 workplace users, who spent an average of 5.1 hours on the computer. In this experiment, users reported wasting on average, 42-43% of their time on the computer due to frustrating experiences. The causes of the frustrating experiences, the time lost due to the frustrating experiences, and the effects of the frustrating experiences on the mood of the users are discussed in this paper. Implications for designers, managers, users, information technology staff, and policymakers are discussed.

Introduction

A September 2001 report of the National Telecommunications and Information Administration reports that as of September 2001, 56.7% adults (employed and over age 25) in the United States use a computer in the workplace (NTIA, 2001). In addition, 81% of those employed in managerial and professional jobs, and 71% of those in technical, sales, and

administrative support jobs utilized computers as part of their work environment. This indicates that in 'white-collar' jobs, computer use is becoming very prevalent.

With the rising ubiquity of computer usage in American society in the home, school, and workplace, research has begun to focus on the possible consequences of such use. Research on computer anxiety, attitudes, and frustration has shown that a disturbing portion of computer users suffer from negative affective reactions towards the computer, which can subsequently affect whether or not they use the computer, and whether or not they use the computer effectively. Research on frustration, both in individuals and organizations, has shown that frustration can lead to maladaptive behaviors that can subsequently lower effective goal-oriented behavior. In addition, research has shown that between one third and one half of the time spent in front of the computer was lost due to frustrating experiences -- when considering both the time it took to fix the problem and any additional time that was lost due to the problem (Ceaparu, Lazar, Bessiere, Robinson, & Shneiderman, 2003).

Because computers are so prevalent in organizations, it is important to examine the role of computers in the organization and the possible consequences arising from their use. In this experiment, 50 workplace users recorded their frustrations with computers through the use of modified time diaries. There are solutions to the causes of user frustration. However, the first step is to understand the causes themselves, which can lead to experimental testing of improved interfaces to address these frustrations, and then implementation of these solutions in industry. Computers play an important role in affecting the performance of individuals within organizations, therefore, this research should be of great interest to businesses and other organizations, because improved interfaces can improve the bottom-line and corporate profit.

Background Research

Frustration

Frustration is often defined in different ways, making the subject itself somewhat ambiguous. Frustration was first introduced by Sigmund Freud as a concept both external and internal in nature and related to the concept of goal attainment. Frustration occurs when there is an inhibiting condition which interferes with or stops the realization of a goal. All action has a purpose or goal whether explicit or implicit, and any interruption to the completion of an action or task can cause frustration. For Freud, frustration included both external barriers to goal attainment and internal obstacles blocking satisfaction (Freud, 1921).

This concept of frustration as a duality is continued in the analysis of frustration as both cause and effect (Britt & Janus, 1940). As a cause, frustration is an external event, acting as a stimulus to an individual and eliciting an emotional reaction. In this case, the emotional response is the effect, and the individual is aroused by this external cause and a response is often directed towards the environment.

Dollard et al. define frustration as "an interference with the occurrence of an instigated goal-response at its proper time in the behavior sequence" (Dollard, Doob, Miller, Mowrer, & Sears, 1939). Because an instigated goal response entails only that the goal be anticipated, frustration is due to the expectation and anticipation of a goal, not the actual attainment of the goal (Berkowitz, 1978). If the goal is unfulfilled, frustration is experienced because satisfaction was not achieved and hopes were suddenly thwarted. The thwarting or hindrance -- terms often used synonymously with frustration -- is not limited to the actual activity in progress, but relates to what the individual is expecting (Mowrer, 1938a).

Frustrations, in all cases, are aversive events (Ferster, 1957) having as their main defining feature the element of a barrier or obstruction. This barrier can take the form of an actual barrier, or an imaginary one such as the response to anticipated punishment or injury (Mowrer, 1938b). A frustrating situation, then, is defined as any “in which an obstacle – physical, social, conceptual or environmental – prevents the satisfaction of a desire” (Barker, 1938). These blocks to goal attainment may be both internal and external (Shorkey & Crocker, 1981), similar to the duality proposed by Freud. Internal blocks consist of deficiencies within the individual such as a lack of knowledge, skill, or physical ability. External blocks could include the physical environment, social or legal barriers such as laws or mores, or the behavior of other people.

Factors Affecting Level of Frustration

The level of frustration experienced by an individual clearly can differ depending on the circumstances surrounding the frustrating experience and on the individuals themselves. One major factor in goal formation and achievement is goal commitment, which refers to the determination to try for and persist in the achievement of a goal (Campion & Lord, 1982). Research on goal theory indicates that goal commitment has a strong relationship to performance and is related to both the importance of the task or outcome and the belief that the goal can be accomplished (Locke & Latham, 2002).

Individuals will have a high commitment to a goal when the goal is important to them and they believe that the goal can be attained (Locke, 1996). The importance of the goal, in addition to the strength of the desire to obtain the goal (Dollard et al., 1939), will affect the level of goal-commitment as well as the strength of the subsequent reaction to the interruption. Self-efficacy, the belief in one’s personal capabilities, can also affect goal commitment (Locke & Latham, 1990) in that the belief about how well a task can be performed when it involves setbacks, obstacles, or failures may affect how committed individuals are to that goal (Bandura, 1986).

Judgments of efficacy are related to the amount of effort expended, how long they persist at the task, and resiliency in the case of failure or setback (Bandura, 1986, 1997b). Self-efficacy influences emotional states as well; how much stress or depression people experience in difficult situations is dependent on how well they think they can cope with the situation (Bandura, 1997a). The level of frustration that people experience, therefore, would be influenced by how important the goal was to them, as well as how confident they are in their abilities. “Because goal-directed behavior involves valued, purposeful action, failure to attain goals may therefore result in highly charged emotional outcomes,” (Lincecum, 2000) including frustration.

Cultural factors can also play a role in the level of frustration experienced by individuals when coming across obstacles to their path of action. Social Learning Theory (Bandura, 1973) states that “rather than frustration generating an aggressive drive, aversive treatment produces a general state of emotional arousal that can facilitate a variety of behaviors, depending on the types of responses the person has learned for coping with stress and their relative effectiveness” (p. 53). Ways of coping with frustration are therefore learned from the society and are governed and constrained by the laws of a society. This can contribute to the level of frustration tolerance that individuals have, which is also affected by their prior experience and task specific self-efficacy.

According to Freud, it is not simply the nature of the frustrating incident that determines how people will react to it. Rather, there is an interplay between the situation and the psychological characteristics of individuals. The level of maturity of the individual also plays a

part in the reactions to frustration (Barker, Dembo, & Lewin, 1965). With maturity, there is an increase in the variety of responses to a situation employed by individuals, in the control of the environment, and in their ability to employ problem-solving behavior and plan steps to obtain the goal. It would appear that learning, which is culturally determined, is a major factor in developing socially acceptable responses to frustration.

Two additional factors that may influence the force of the frustration are the severity of the interruption and the degree of interference with the goal attainment (Dollard et. al. 1939). All obstructions are not equally frustrating, and the severity and unexpectedness of the block will also factor into the strength of the response. In addition, if individuals perceive that the thwarting was justified by socially acceptable rules, as opposed to being arbitrary, the frustration response may be minimized (Baron, 1977). This may be due to the lowering of expectations because of extra information available to the individual. As stated above, it is the anticipation of success that affects frustration, and not the actual achievement of the goal. Therefore, if individuals expect to be thwarted or have a low expectation of success, frustration may be minimized.

Responses to Frustration

The responses to frustration by individuals can be either adaptive or maladaptive (Shorkey & Crocker, 1981). Adaptive responses are constructive and are implemented to solve the problem that is blocking goal attainment. They may include preemptive efforts to avoid the problem, or once the problem is encountered, problem solving strategies to overcome or circumvent the problem. Freud lists two types of adaptive responses: 1) transforming stress into active energy and reapplying this energy towards the original goal, and 2) identifying and pursuing alternative goals. Maladaptive responses, on the other hand, are characterized by a lack of constructive problem solving and often make the frustrating experience worse by creating additional problems. These maladaptive responses may be further categorized into objective (aggression, regression, withdrawal, fixation, resignation) and subjective (extrapunitive, intropunitive, impunitive) responses (Britt and Janus 1940).

Organizational Frustration

Organizational frustration has been defined by Paul Spector in a very similar fashion, and refers to an interference with goal attainment or maintenance that is caused by some stimulus condition within the organization (Spector, 1978). It has been further narrowed to be defined as the interference with an individuals ability to carry out their day to day duties effectively (Keenan & Newton, 1984). The sources of organizational frustration put forth by Spector include the physical environment (both natural and man-made), the organizational structure and climate, the rules and procedures of the organization, and individuals both in and out of the organization. In addition, the concept of situational constraints (Peters & O'Connor, 1980) has been hypothesized to contribute to organizational frustration (Storms & Spector, 1987). Spector (1978) suggested four reactions to organizational frustration: 1) an emotional response of anger and increased physiological arousal, 2) trying alternative courses of action, 3) aggression, and 4) withdrawal. Of the behavioral reactions, only the second one – that of trying alternative courses of action to obtain the goal – is an adaptive response, while the other three are maladaptive. It is likely that the emotional reaction accompanies one of the three behavioral reactions, although the emotional reaction may be maladaptive by itself and become a further impediment to goal attainment. Clearly, should an individual become frustrated, it is in the best interests of the

organization to have the individual respond in an adaptive way and attempt to find another solution to the problem in a clear decisive manner. Spector also put forth the idea that some mild forms of frustration may be seen as challenges rather than problems for some individuals, thus causing a motivational effect rather than a hindering effect and increasing the likelihood of an adaptive response rather than a maladaptive one.

Behavior exemplifying two of the three maladaptive responses, in an organization, are described by Spector in his model. Examples of withdrawal behavior in an organization could include the abandonment of a goal, absenteeism, or turnover. Examples of organizational aggression include interpersonal aggression, sabotage, and withholding of output. Both of these maladaptive responses are thought to lead to a decrease in job performance. However, evidence for the frustration-performance link is mixed, as some cases of mild frustration are found to increase task-performance presumably due to increased arousal (Spector, 1975), whereas other studies find that frustration actually inhibits both task performance and learning of a new task.

Other relationships with organizational frustration have also been tested. In a sample of employed individuals, significant relationships were found between both self-reported sabotage and interpersonal aggression with level of frustration as measured by the Organization Frustration Scale (Spector, 1975). Frustration was also found to be strongly correlated to a self-reported desire to leave the place of employment. In another study of 401 employed engineers, Keenan and Newton found that organizational climate, role stress, and social support all correlated positively with environmental frustration (Keenan & Newton, 1984). Additionally, they found that frustration was significantly related to angry emotional reactions, latent hostility and job dissatisfaction.

Additional research has shown that organizational frustration is positively correlated with several negative behavioral reactions - aggression, sabotage, hostility and complaining, withdrawal, and intent to quit (Storms & Spector, 1987). In an effort to examine the antecedents of the response choice (adaptive or maladaptive) Storms & Spector also tested for the moderating effect of locus of control, hypothesizing that individuals with an external locus of control would exhibit more counterproductive behavior during times of frustration than those with internal locus of control. Using the same Organizational Frustration scale, Jex and Gudanowski examined the role of self-efficacy beliefs and work stress (Jex & Gudanowski, 1992). They found that individual efficacy beliefs were significantly negatively correlated with level of organizational frustration, indicating that those with less belief in their abilities at their job suffered more frustration than those with high efficacy beliefs. However, they did not find that efficacy beliefs mediated the relationship between stressors and frustration, indicating that self-efficacy does not affect the level of frustration experienced due to external stressors such as situational constraints.

Computer Anxiety

The reactions of people to computers have been studied extensively, particularly attitudes towards the computer (Loyd & Gressard, 1984; Murphy, Coover, & Owen, 1989; Nash & Moroz, 1997) computer anxiety (Cambre & Cook, 1985; Cohen & Waugh, 1989; Glass & Knight, 1988; Maurer, 1994; Raub, 1981; Torkzadeh & Angulo, 1992), and computer self-efficacy (Brosnan, 1998; Compeau & Higgins, 1995; McInerney, McInerney, & Sinclair, 1994; Meier, 1985). Each of these variables, combined with the factors listed above, can affect how frustrated individuals will become when they encounter a problem while using a computer.

The number of times a problem has occurred before can affect their perception of the locus of control, and therefore influence their reaction as well. This may be related to anxiety, as people with low computer self-efficacy may be more anxious (Brosnan, 1998; Meier, 1985) and more likely to view the computer suspiciously and react with great frustration when something occurs, especially when they have run into it before. Different levels of anxiety will affect performance when something unforeseen or unknown occurs, causing anxious people to become more anxious (Brosnan, 1998). On the other hand, the level of experience may temper this if the prior experience increases computer self-efficacy (Gilroy & Desai, 1986) by lowering anxiety and reducing frustration when a problem occurs. The perceived ability to fix problems on the computer, as well as the desire to do so may also affect levels of frustration. If instead, these problems are seen as challenges, they may not be as frustrating, which is most likely directly related to level of prior experience as well as computer self-efficacy.

Computer Frustration

Frustration with technology is a major reason why people cannot use computers to reach their goal, hesitate to use computers, or avoid computers altogether. A recent study from the Pew Internet and American Life study found that a large percentage of people never go online, because they find the technology to be too frustrating and overwhelming (Pew, 2003). Currently, 42% of Americans do not use the Internet, in large part because they find it to be frustrating and confusing. This is not surprising; previous research on user frustration found that users wasted nearly one-third to one-half of the time spent on the computer, due to frustrating experiences (Bessiere, 2002; Bessiere, Lazar, Ceaparu, Robinson, & Shneiderman, 2003).

Unfortunately, computer applications are often designed with interfaces that are hard to use, and features that are hard to find. Even government web sites, which are supposed to provide easy access to government information for all citizens, are frequently hard to use and produce high levels of user frustration (Ceaparu, 2003). Frustration with technology can lead to wasted time, changed mood, and affected interaction with colleagues. When users in a workplace are frustrated with their computers, it can lead to lower levels of job satisfaction (Murrell & Sprinkle, 1993). In some cases, user frustration with technology can even lead to increased blood volume pressure and muscle tension (Riseberg, Klein, Fernandez, & Picard, 1998)

Research on computer frustration has shown that that computer self-efficacy and attitudes play a significant role in reducing the frustration levels in computing. Level of comfort with the computer and the determination to fix a problem, which are associated with a high level of computer self efficacy, both appear as important factors in both the immediate experience of frustration as well as the overall frustration level after a session of computer use. In the previous study on computer frustration, computer attitude variables mediated the experience of frustration but experience did not. Simply using a computer, therefore, does not lessen user frustration; rather it is one's attitude towards it and comfort with it.

There is a measurable benefit to improved usability of user interfaces for lower user frustration (Bias & Mayhew, 1994). Many well-known companies, such as IBM, Staples, the National Football League, and Macy's focus on improving their interface design, which leads to measurable improvement of the bottom line (Clarke, 2001; Tedeschi, 1999). For instance, when Macy's made their web site search engine easier to use, the conversion rate (the rate at which site visitors are "converted" into buyers) went up 150% (Kemp, 2001). Staples.com used feedback from users to improve their online registration pages, to make them easier to use. After

improving the usability of the registration pages, the registration drop-off rate (the number of people who begin registering but fail to complete the registration) decreased by 53% (Roberts-Witt, 2001). After losing market share, AOL yielded to customer complaints and removed a majority of the pop-up advertisements from their service (Hu, 2002). Companies that have re-designed interfaces for log-on screens and for user forms have seen improvements in employee productivity that can be measured, in tens or hundreds of thousands of dollars (Nielsen, 1994).

Research Methodology

To learn more about user frustration with technology in the workplace, data was collected through the use of modified time diaries. Users recorded data about their frustrations as the frustrations occurred. Surveys would not be an appropriate data collection methodology for this research, since users trying to recall frustrations from their past experiences might over-estimate or under-estimate the level of frustration and the time wasted (Fowler, 1993). In addition, data logging cannot effectively measure frustration, since data logging would only work for system errors, or other occasions when the systems indicated an error state. There are many events that are frustrating for users (such as spam or pop-up advertisements), and occur when the system is operating in a correct state. This same methodology was used in the previous study of computer frustration in students (Ceaparu, Lazar, Bessiere, Robinson, and Shneiderman, 2003).

Subjects in this study were encouraged to perform their typical work-related tasks, and record, as a part of their time diaries, any frustrating experiences. Tasks are not pre-assigned to subjects, because user frustration is correlated to the importance of the task (Bessière, Ceaparu, Lazar, Robinson, & Shneiderman, 2003). When tasks are important to users, users report higher levels of frustration than when tasks are not important. Pre-assigned tasks would therefore not accurately model the user frustration in an average workday. The following protocol was used:

1. Fill out demographic information (age, gender, computer experience, etc.)
2. Fill out a pre-session survey (noting current mood) (Appendix A)
3. Perform work-related computer tasks of their choosing, for a minimum of one hour total.
4. Fill out frustration experience forms, whenever the subject feels frustrated. These forms describe the cause, nature, and severity of the frustrating experience. (Appendix B)
5. Fill out a post-session survey (measuring frustration after the session ended) (Appendix C)
6. After completing the post-session survey, subjects fill out a reimbursement form and return all of the materials via postal-mail to the researchers.

RESULTS

Data collection took place from mid-2002 until 2003. A total of 50 subjects took part in the study. Each subject was a workplace user of computers, and was paid \$25. The workplaces represented in this study include healthcare (15), law (3), education (8), information technology (11), non-profit-other (5), for-profit-other (2), government (3), and 3 subjects did not indicate their workplace. The average age of users was 35.95 years (with a range of 23 to 76 years old). The average number of years of computer experience was 2.38 years (with a range of less than a year, to 25 years of experience). A total of 149 frustrating experiences were reported, with each participant reporting between 1 and 6 experiences. Users recorded their experiences, in time

diaries, for a period of 5.1 hours, on average. This paper reports the causes and severity of the frustration, highlighting the responses to frustration, as well as the time lost. A separate paper will address how the frustration impacted on the individuals mood and interaction with others.

Word processing and e-mail produced the largest number of frustrating experiences, probably reflecting that these applications were used most often (Table 1). There were several frustrating experiences involving moving data from one application to another application, such as email content into word processing and even moving content among similar applications, such as Word to WordPerfect. Many frustrating experiences were inhibiting but did not ultimately prevent the task from completion.

Table 1: Applications that were the source of frustrating experiences

Problem source	Frequency of problem sources
Web browsing	17
Email	28
Other Internet Use	11
Video/Audio Software	1
Word Processing	34
Chat and Instant Messaging	1
File Browsers	1
Programming Tools	2
Spreadsheet Programs	9
Graphic Design Programs	1
Presentation Software	1
Database Programs	6
Other	37
Total	149

Most participants were already familiar with the frustrating experience from previous experiences and know how to solve it (Table 2). Most solutions involved simply redoing the task or rebooting and then redoing the task. Other solutions involved work-arounds and as a last resort finding help externally. The type of solution taken was independent of demographic differences. In only one frustrating experience did the user consult a manual, and only in two experiences did the user consult online help.

Table 2: Solutions taken by participants

Solution taken	Frequency of solutions
I knew how to solve it because it happened before	35
I figured out a way to fix it myself	9
I was unable to solve it	16
I ignored the problem or found an alternative	20
I tried again	5
I restarted the program	15
I consulted online help	2
I asked someone for help	16
I rebooted	29
I consulted a manual or a book	1
Total	148

Note: some responses were left blank by participant

The time lost due to frustrating experiences was one of our key measures. Users, in general, spend more time recovering from an incident than initially working through the incident. Both the initial time spent on responding to the frustrating experience, as well as the time to recover from any work lost due to the problem, contribute to the total time lost. The method for computing percentage of time lost is as follows:

$$\text{Percent Time Lost} = (\text{MS} + \text{MR}) / \text{MT}$$

Where MS is minutes spent to solve the problem, MR is minutes spent to recover lost work, and MT is total minutes spent on the computer (Ceaparu, Lazar, Bessiere, Robinson, and Shneiderman, 2003).

For each user, the amount of time lost to respond to the initial problem, as well as the time lost to recover from the problem, was added for all frustrating experiences reported by that user and then divided by the overall time spent by that user on the computer. The final figure represents the percent time lost by that user of the time that they spent on the computer. Table 3 gives a sample of these data calculations from one user.

Table 3. Sample of time lost statistics for one user

	Minutes Spent to Solve Problem	Minutes Spent to Recover Lost Work	Total Minutes Lost	Total Minutes Spent on the Computer	Percent Time Lost to Solve Problem	Percent Time to Recover Lost Work	Percent Time Lost
A sample user	30	50	80	183	16.4%	27.3%	43.7%

The percentages for time lost to solve the problem, time to recover lost work, and time lost, after being normalized for each user, were then averaged over the population of 50 users (Table 4). Each column in table 4 is calculated from the data itself and not from the previous numbers in the table. Therefore, percentage time lost is not exactly equal to the sum of the figures in the first two columns. Percentages are given for all users, and for all users minus the one outlier frustrating experience (see paragraph below).

One user reported an extremely long duration frustrating experience, which we considered to be an outlier. The one outlier frustrating experience was reported as 540 minutes to solve the problem, and another 540 minutes to recover lost work. The cause of the frustrating experience was a hardware problem, where the user reported assigning IRQs to hardware, and every time that the computer re-booted, the operating system would re-assign those IRQs. The user reported disabling the problem devices to complete the current task. Due to the large amount of time wasted, we therefore felt that this one frustrating experience should be separated out as an outlier. The user reported two other frustrating experiences, but those were well within the typical range reported. The other frustrating experiences from the same subject are therefore included (Table 4).

Table 4. Averages for percent time lost to solve problem, time to recover lost work, and time lost for all users

	Percent Time Lost to Solve Problem	Percent Time to Recover Lost Work	Percent Time Lost
Total without outlier	20.3%	20.2%	42.7%
Total with outlier	21.5%	22.2%	43.7 %

Problems with word processing cost participants the most amount of time in total (1225 minutes lost), followed by problems with email (666 minutes lost) (Table 5). This did correlate with the applications that caused the highest number of frustrating experiences. The applications that were uncommon sources of frustrating experiences (such as programming tools, database software, and presentation software) often required more time per incident, as the problems were rare and complex to solve.

Table 5: Breakdown of total minutes lost and average minutes lost per frustrating experience by application problem source

Problem source	Reports		
	Total minutes lost	# of frustrating experiences	Average minutes lost per frustrating experience
Email	666	28	23.8
Web Browsing	244	17	14.4
Other Internet Use	105	11	9.5
Word Processing	1225	34	36.0
File Browsers	4	1	4.0
Video/Audio Software	20	1	20.0
Programming Tools	140	2	70.0
Graphic Design Programs	5	1	5.0
Database Programs	335	6	55.9
Chat and Instant Messaging	2	1	2.0
Presentation Software	105	1	105.0
Spreadsheet Programs	604	9	67.1
Other	865	37	23.4
Total	4320	149	28.9

Categories of frustrating experiences were based on a previous study (Ceaparu, Lazar, Bessiere, Robinson, and Shneiderman, 2003) with minor changes to accommodate terms used by our participants (Table 6). Major categories were grouped by the behavior described in each frustrating experience. System crashes were the most commonly-reported frustrating experience, accounting for 21 of the 149, and were caused by specific programs as well as the operating system itself. While many of these problems are hardware-related or technical-related (such as printing problems and system crashes), there were a number of frustrating experiences that were caused by interface-related issues (such as uncontrollable pop-up windows, hard to find features, and unpredictable behavior of application, and unclear error messages). For instance, there were 19 experiences with missing/hard-to-find/unusable features, 4 experiences with uncontrollable pop-up windows, and 5 experiences with unclear error messages. These interface-related causes of user frustration are easily solvable, when attention is paid to appropriate user interface design. As discussed in previous portions of the paper, when these interface improvements are made, it leads to improved user productivity and organizational profitability.

Table 6: Specific causes of frustrating experiences

Internet	Applications	Operating System	Hardware	Other
Lost / Dropped Connections { 7 }	Missing / Hard to find Unusable Features { 19 }	System Crash Caused by Operating System { 21 }	Printing Problems { 10 }	User Kicked from System { 5 }
Sending / Receiving Email and accessing attachments { 6 }	Application Crash { 11 }	File Browser Operations { 2 }	Hardware Conflicts { 3 }	Multi user File Access and Permission Issues { 5 }
Uncontrollable Pop-up window { 4 }	Buggy, Incorrect behavior of program { 10 }	Multitasking Failure { 1 }	Device Failures { 3 }	Password Not working { 2 }
Internet Login Failures { 3 }	Excessive Slow Operation { 8 }			Virus / Malicious Program { 1 }
Browser Failure { 2 }	Unpredictable Response of program { 6 }			Local Network Connection Access Failure { 1 }
File Download Failures { 2 }	Unclear Error Messages { 5 }			Power Failure { 1 }
Plug-in Failure { 1 }	Installation Issues { 4 }			
	Application Crash that Froze the entire System { 4 }			
	Unknown File Format { 1 }			

Note: some responses were left blank by participant

The participants express strong emotional reactions to the frustrating experiences (Table 7). For instance, in 60 of the frustrating experiences, users felt angry at the computer, in 34 experiences, users felt helpless/resigned, and in 15 experiences, users felt angry at themselves. Since users

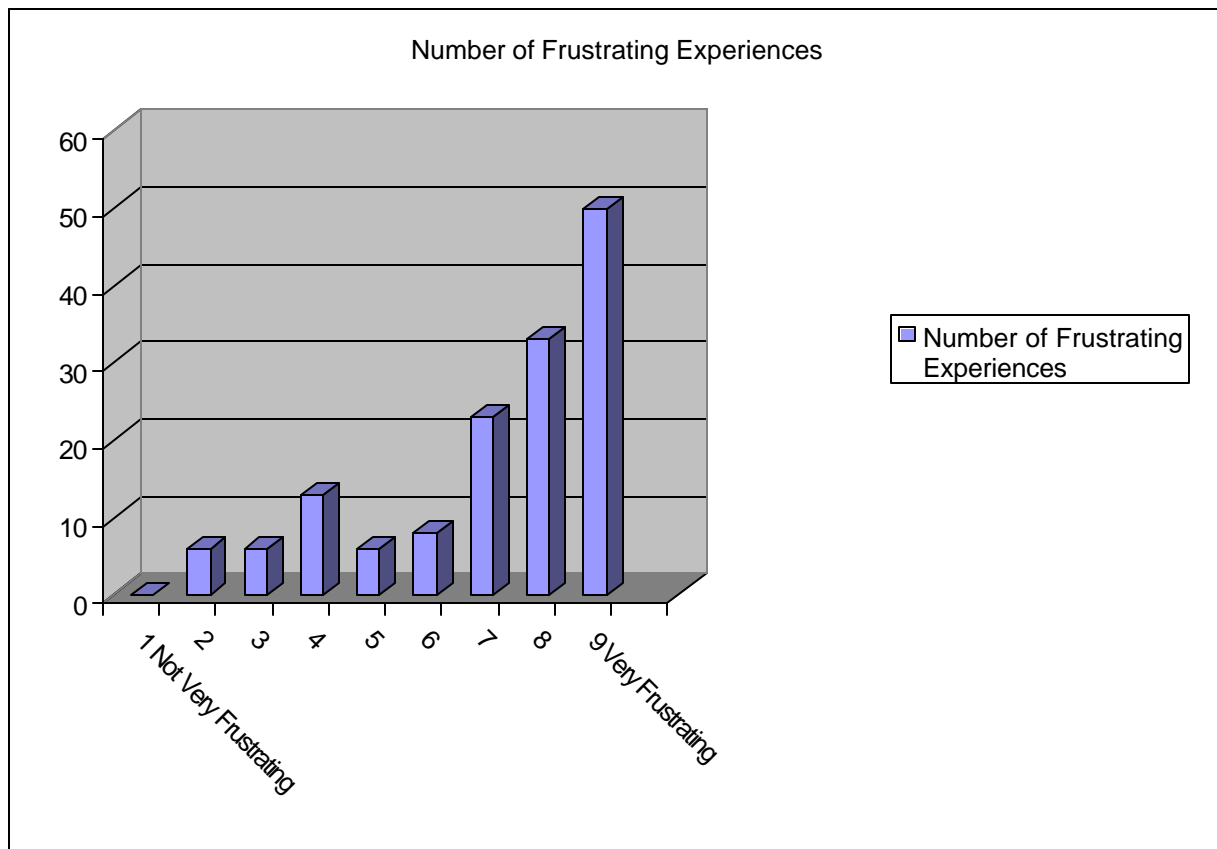
may have more than one emotional reaction, these numbers for table 7 add up to more than the 149 frustrating experiences reported. Using a 1 to 9 numeric scale, 106/149 of the frustrating experiences were reported to have frustration levels of 7, 8, or 9 (Figure 1). These high levels of frustration can have an impact on physiological variables. For instance, in a previous study of user frustration, researchers found that when typical users get frustrated with their computer, it affects blood volume pressure (Riseberg, Klein, Fernandez, & Picard, 1998).

Table 7: User feelings per incident

Expressed Feeling	Number of Reports
Angry at the computer	60
Angry at yourself	15
Helpless / Resigned	34
Determined to fix it	27
Neutral	17
Other	26

Note: Some participants had multiple feelings per incident

Figure 1: Bar graph of reported frustration levels



Unfortunately, it seems that these frustrating experiences are not rare occurrences. From the frustrating experiences reported, users were asked to indicate whether this same event had occurred previously, and if so, how often (Table 8). For instance, for 25 of the frustrating experiences, users reported that the same event occurs more than once a day. For 21 of the frustrating experience, users reported that the event occurred several times a week.

Table 8: Frequency of problems

Frequency of problem	Number of reports
More than once a day	25
One time a day	7
Once a week	15
Once a month	11
Several times a week	21
Several times a month	29
Several times a year	9
First time it happened	29

Note: Some responses left blank by participant

Discussion

From the results of this study, it is clear that user frustration is a problem in the workplace. Since users lose more than 40% of their time, these frustrating experiences have an impact on the individuals, and their organizations. From an individual point of view, users waste a large amount of time, which slows their completion of work, limiting their time with family, friends, and co-workers. It also can affect their emotional state. These frustrating experiences also harm organizations by undermining productivity, lowering quality, and raising stress levels. The investment in improving user interfaces would yield large payoffs; several studies suggest that the cost of the interface improvement is made up 5, 10, or 20 times over (Bias and Mayhew, 1994).

It is clear from this study and previous work that user frustration is a major problem. In the previous study of 111 subjects, the subjects were university students, and their friends and family members. This current study was limited to workplace users. However, the results of the two studies were surprisingly similar.

Table 9 reports the top 3 applications causing a frustrating experience from both the previous study and the current study. The applications causing the most frequent frustrating experiences for the student frustration study were web browsing, email and word processing. In the workplace frustration study, the top 3 application sources encountered by the users were the same, but in reverse order: word processing, email, web browsing. The top 3 solutions taken by the participants to solve the problems that occurred in the student study were: they knew how to solve it from previous experience, they figured out a way or they were unable to solve it. For the workplace study, the top 3 solutions cited were that they knew how to solve it from previous experience, they rebooted, or ignored the problem/found an alternative.

Table 9: Applications causing the largest numbers of frustrating experiences

Student Study-Causes of Frustration	Workplace Study-Causes of Frustration
1. Web Browsing	1. Word Processing
2. E-mail	2. E-mail
3. Word Processing	3. Web Browsing

In both studies, the levels of frustration were at the high end of the scale. For instance, 7,8, and 9 are the highest scores on the frustration scale, and in both studies, large percentages of subjects reported their frustrations being in that range. In the student frustration study, 63.3% (236 out of 373) of the frustrating experiences caused high levels of frustration. In the workplace study, 71.1% (106 out of 149) of frustrating experiences caused high levels of frustration.

The amount of time lost was also similar in the different frustration studies. Table 10 describes the time lost in the various studies, both with and without outliers. The numbers are very similar. In the previous study with students, there were two phases: self-reports and observations. These

data points are listed separately. In the previous study with students, the average percentage of time lost ranged from 38.9% (for self-reports without the 5 outliers) to 50.1% (for self-reports with the 5 outliers). In this workplace study, the average percentage of time lost ranged from 42.7% (without outliers) to 43.7% (with outliers). We think that the difference in ranges was logical, due to the numbers of subjects involved in the two studies. In the previous student study, 111 subjects took part, whereas in this workplace study, only 50 users took part. With a larger number of users taking part, it logically follows that there will be more outliers, and therefore, a wider percentage spread.

Table 10: Time lost in the three studies, with and without outliers.

	Average time lost (with outliers)	Average time lost (without outliers)
Student study self-reports	50.1%	38.9%
Student study observations	49.9%	41.9%
Workplace study	43.7%	42.7%

When looking at the specific causes of the frustrating experiences that occurred, the student study finds that the top 5 were: error messages, timed out/dropped/refused connections, application freezes, missing/hard to find/unusable features, long download time. The workplace study finds that the top 5 were: OS crashes, missing/hard to find/unusable features, application crashes, hardware problems, buggy/undesirable behavior of program. Many of these problems (such as error messages, hard-to-find features, and undesirable behavior) are caused by poorly-designed interfaces, and therefore, can be solved with more usability testing and more user involvement in the interface development. It is interesting to note that some of the causes of frustration for the student participants, such as timed out/dropped connections, and long download times, did not appear as frequent frustrations for workplace participants. It is likely that the network connection at a workplace is of higher quality and speed, therefore less likely to cause frustration due to either response time or dropped connection. However, many of the software applications are the same, regardless of user population or location, and are highly likely to cause frustration.

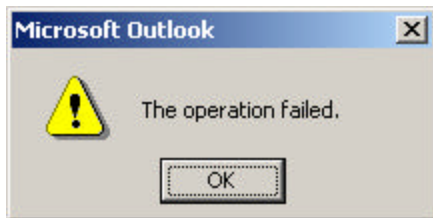
Conclusion

This study with 50 workplace users adds to the growing evidence that user frustration is a major problem. Further studies with a narrower focus may isolate and measure contributing factors, but there is enough evidence to encourage change in the industry.

Improving user interface design is one clear opportunity because the payoffs will be immediate and benefit many users. To build better interfaces, more user involvement is needed in the interface design process. Designers should follow the interface guidelines that exist. User training will also help, especially if it addresses problem solving strategies that will help build self-efficacy. Even small changes in the interface can make a big impact on user satisfaction. For instance, in recent studies of the FedStats web site, changing the interface of a governmental web site increased user satisfaction and performance nearly 100% (Ceaparu and Shneiderman, 2004). If link titles are unclear or are not where the users expect, they may not be able to complete their

tasks (Daniel and Lazar, 2004). Unclear wording has been found as a major problem in interface design, regardless of the user population or the task. For instance, in a usability study of a university web site, 5 users all failed to find the information that they were looking for (current course schedules) because the information was listed under an unclear heading (“Student Life”). From a technology coding point of view, changing the words displayed is relatively simple. In addition, the usability methods needed to find out that the wording is unclear, are also relatively simple. Paper-based usability testing methods such as card sorting or paper prototypes can help find flaws in interface wording. Since many users reported being frustrated by unclear error messages or by hard-to-find features, interface designers should be directed to review all messages and instructions. Good guidelines for error message design have existed since 1982, but these guidelines are rarely followed. (Shneiderman, 1982). Error messages should be positive, provide information for users (in their language) on what occurred, and offer suggestions on how to continue. Current error messages rarely assist users (see figure 2 for an example of this). Improved error messages can reduce user frustration while making users more satisfied and productive. (Lazar and Huang, 2003). While all causes of user frustration are not as easily solvable, a large percentage of user frustrations ARE solvable. And there are many resources out there to help improve interface design, such as books, automated software tools, guidelines, and other resources (See www.hcibib.org or www.hcirn.com for more information).

Figure 2. An unclear error message



The implications for stakeholders might be separated out by:

Designers can build more productive systems by learning what frustrates users in the workplace. Systems can be modified not only to have fewer errors but also to be more helpful. This may include better error messages, better and helpful descriptions of problems which can reduce the time needed to fix an issue, as well as designs based more closely on the way users work particularly with respect to how end users handle errors. This would improve efficiency overall as systems would be better equipped to handle problems faster and allow for the system to get back to operating normally (without problems) and in general make things more usable.

Managers can benefit by learning where frustrations occur within computing systems of their employees. This would help them to construct a more productive workplace, reduce workflow bottlenecks, and produce more satisfied employees. They can recommend training for employees and make more appropriate choices in software acquisitions.

Users of computers will appreciate learning that they are not alone in their frustrations. They can take steps to improve their training and increase their knowledge, but they can accelerate improvement by being consumer activists who report problems, complain to designers, and suggest improvements.

Information Technology Staff can be better prepared to handle frustrated users and learn which type of technical problems produce the largest frustration. This can help things move more smoothly and even help IT staff make better recommendations to managers and policymakers. IT Staff should also be better situated as the middleman and be able to get better information between users and vendors when understanding frustration in the workplace.

Policymakers, in industry and government, should recognize the severity of the productivity loss due to user frustration. Increased research funding, improved training, better data collection, and increased public awareness of the problems will help produce appropriate changes.

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Pre-Session Survey (Appendix A)

Email address: _____

Section I: Demographic Information

1. Age _____
2. Gender: F M
3. Education:

<input type="checkbox"/> High School Graduate	<input type="checkbox"/> Fresh/Soph in College	<input type="checkbox"/> Jr./Sr. in College
<input type="checkbox"/> College Graduate	<input type="checkbox"/> Masters Degree	<input type="checkbox"/> Doctoral-level
4. In what field are you employed? _____
5. What is your job title? _____

Section II: Computer Experience and Attitudes

1. How many years have you been using a desktop or laptop computer for home or work use? _____
2. How many hours per week do you use a desktop or laptop computer? _____
3. What type of Operating System is installed on the computer that you are currently using?

<input type="checkbox"/> DOS	<input type="checkbox"/> MacOS	<input type="checkbox"/> Unix/Linux	<input type="checkbox"/> Windows 95
<input type="checkbox"/> Windows NT	<input type="checkbox"/> Windows 98	<input type="checkbox"/> Windows ME	<input type="checkbox"/> Windows 2000
<input type="checkbox"/> Windows XP			
4. What type of applications and programs do you typically use? (check all that apply)

<input type="checkbox"/> Email	<input type="checkbox"/> Other Internet Use	<input type="checkbox"/> Graphic Design Programs
<input type="checkbox"/> Chat/Instant Messaging	<input type="checkbox"/> Word Processing	<input type="checkbox"/> Programming Tools
<input type="checkbox"/> Web Browsing	<input type="checkbox"/> Spreadsheet Program (Excel)	<input type="checkbox"/> Database management/ Searching
<input type="checkbox"/> Presentation Tools (powerpoint)	<input type="checkbox"/> Other (please explain) _____	<input type="checkbox"/> Multimedia (audio/video)
5. How many years have you been using the internet? _____
6. How many hours per week do you spend online? Please indicate the amount of time that you are actually using the computer while online, not simply the amount of time you are connected to the internet. _____
7. At work, do you ☐ Have a permanent connection to the internet **OR** ☐ dial in through a modem
8. Which of the following do you do when encountering a problem on the computer or application that you are using?

☐ try to fix it on my own ☐ consult a manual/help tutorial ☐ Ask help desk/consultant for help
☐ Ask a friend/relative for help ☐ Give up or leave it unsolved

9. How sufficient is your computer software and/or hardware for the work that you need to do?

Not at All 1 2 3 4 5 6 7 8 9 Very Sufficient

Section III: For the following questions, please choose the number that best corresponds to your feelings

1. Computers make me feel:

Very Uncomfortable 1 2 3 4 5 6 7 8 9 Very Comfortable

2. When you run into a problem on the computer or an application you are using, do you feel:

Anxious 1 2 3 4 5 6 7 8 9 Relaxed/Indifferent

3. When you encounter a problem on the computer or an application you are using, how do you feel about your ability to fix it?

Helpless 1 2 3 4 5 6 7 8 9 Confident I can fix it

4. How experienced do you think you are when it comes to using a computer?

Very Inexperienced 1 2 3 4 5 6 7 8 9 Very Experienced

5. When there is a problem with a computer that I can't immediately solve, I would stick with it until I have the answer.

Strongly Disagree 1 2 3 4 5 6 7 8 9 Strongly Agree

6. If a problem is left unresolved on a computer, I would continue to think about it afterward.

Strongly Disagree 1 2 3 4 5 6 7 8 9 Strongly Agree

7. Right now, how satisfied with your life are you?

Very Unsatisfied 1 2 3 4 5 6 7 8 9 Very Satisfied

8. How often do you get upset over things?

Not Very Often 1 2 3 4 5 6 7 8 9 Very Often

9. Right now, my mood is:

Very Unhappy 1 2 3 4 5 6 7 8 9 Very Happy

FRUSTRATING EXPERIENCE FORM—(Appendix B)

Please fill out this form for each frustrating experience that you encounter while using your computer during the reporting session. This should include both major problems such as computer or application crashes, and minor issues such as a program not responding the way that you need it to. Anything that frustrates you should be recorded.

1. What were you trying to do?

2. On a scale of 1 (not very important) to 9 (very important), how important was this task to you?

Not very important 1 2 3 4 5 6 7 8 9 Very Important

3. What software or program did the problem occur in? If the problem was the computer system, please check the program that you were using when it occurred (check all that apply).

<input type="checkbox"/> email	<input type="checkbox"/> file browsers	<input type="checkbox"/> presentation software (e.g. powerpoint)
<input type="checkbox"/> chat and instant messaging	<input type="checkbox"/> spreadsheet programs (e.g. excel)	<input type="checkbox"/> media (audio/video software)
<input type="checkbox"/> web browsing	<input type="checkbox"/> graphic design	<input type="checkbox"/> other _____
<input type="checkbox"/> other internet use	<input type="checkbox"/> programming tools	
<input type="checkbox"/> word processing	<input type="checkbox"/> database management/ searching software	

4. Please write a brief description of the experience:

5. How did you ultimately solve this problem? (please check only one)

<input type="checkbox"/> I knew how to solve it because it has happened before	<input type="checkbox"/> I ignored the problem or found an alternative solution
<input type="checkbox"/> I figured out a way to fix it myself without help	<input type="checkbox"/> I was unable to solve it
<input type="checkbox"/> I asked someone for help. Number of people asked _____	<input type="checkbox"/> I tried again
<input type="checkbox"/> I consulted online help or the system/application tutorial	<input type="checkbox"/> I restarted the program
<input type="checkbox"/> I consulted a manual or book	
<input type="checkbox"/> I rebooted	

6. Please provide a short step by step description of all the different things you tried in order to resolve this incident.

7. How often does this problem happen? (please check only one)
☐ more than once a day ☐ one time a day ☐ several times a week ☐ once a week
☐ several times a month ☐ once a month ☐ several times a year ☐ first time it happened

8. On a scale of 1 (not very frustrating) to 9 (very frustrating), how frustrating was this problem for you?

Not very frustrating 1 2 3 4 5 6 7 8 9 Very frustrating

9. Of the following, did you feel:
☐ angry at the computer ☐ angry at yourself ☐ helpless/resigned
☐ determined to fix it ☐ neutral ☐ other: _____

10. How many minutes did it take you to fix this specific problem? (if this has happened before, please account only for the current time spent) _____

11. Other than the amount of time it took you to fix the problem, how many minutes did you lose because of this problem? (if this has happened before, please account only for the current time lost; e.g. time spent waiting or replacing lost work). _____
Please explain:

12. Until this problem was solved, were you able to work on something else?
☐ Yes ☐ No
Please explain:

Post-Session Survey (Appendix C)

Email address: _____

For the following questions, please circle the number that best corresponds to your feelings.

1. Right now, my mood is:

Very Unhappy 1 2 3 4 5 6 7 8 9 Very Happy

2. We asked you to record your frustrating experiences. Overall, how frustrated are you after these experiences?

Not Frustrated at All 1 2 3 4 5 6 7 8 9 Very Frustrated

3. How will the frustrations that you experienced affect the rest of your day?

Not at All 1 2 3 4 5 6 7 8 9 Very Much

4. Are the incidents that occurred while you were recording your experiences typical of your everyday computer experience?

Yes No

5. In general, do you experience more or less frustrating incidents while using a computer on an average day?

Less 1 2 3 4 5 6 7 8 9 More

6. Did these frustrating experiences impact your ability to get your work done?

No impact 1 2 3 4 5 6 7 8 9 Severe impact

7. Did these frustrating experiences impact your interaction with your co-workers?

No impact 1 2 3 4 5 6 7 8 9 Severe impact