

Trust as an Underlying Factor of System Administrators' Interaction Style Preferences

Leila Takayama

Department of Communication
Stanford University
Stanford, CA 94305-3230, USA
takayama@stanford.edu

Eser Kandogan

IBM Almaden Research Center
650 Harry Road
San Jose, CA 95120, USA
eser@us.ibm.com

ABSTRACT

Sysadmins are the unsung heroes of the information age, working behind the scenes to configure, maintain, and troubleshoot the computer infrastructure that underlies much of modern life. While GUIs are being offered for system administrators, they mostly continue to use CLIs. Command-Line Interfaces (CLIs) are typically the interface of choice for most sysadmin tasks, with Graphical User Interfaces (GUIs) occasionally used under some situations. In this paper we provide insight for this preference based on an extensive survey, analyze why these power users perceive CLIs more effective than GUIs, and discuss findings also supported by observations from field studies. Our analysis indicates that cognition-based trust and monitoring play major roles in the system administration tool selection.

Author Keywords

System Administration, Command Line Interfaces, Graphical User Interfaces, Trust

ACM Classification Keywords

H5.2 [Information Interfaces and Presentation]: User Interfaces – *Interaction styles*; K6.4 [Management of Computing and Information Systems]: System Management.

INTRODUCTION

In the system administrator (sysadmin) community there is a "command line macho" that dismisses the Graphical User Interfaces (GUIs) as toys for the kids and suggests that real sysadmins use Command-Line Interfaces (CLIs). It is not uncommon to find negative comments about GUIs such as the survey response in Figure 1. Gelernter offers an explanation in his Paradox of Beauty that the elegant combination of simplicity and power is perceived as weak, ineffective, and not masculine [7].

Human-Computer Interaction (HCI) has historically

focused upon ease of use. For sysadmins, on the other hand, power, efficiency, reliability, robustness, and accuracy may be more important than ease of use. Many system vendors offer GUI tools for sysadmins taking it for granted that GUIs are better without much consideration of the work context. If end-users are analogous to drivers, who do not need to necessarily know how cars work in order to use them, system administrators are more like car mechanics in that they need to have a more thorough understanding of the systems in order to maintain and troubleshoot them. Perhaps, it is not a matter of GUIs vs. CLIs, and we need to take a deeper look at the issues to understand what makes each effective and research how to make better interfaces for power users, too, with serious consideration of the work context.

System Administrators operate within large-scale, complex, risky environments that present unique technical, social, cognitive, and business conditions, posing unique challenges to the HCI practitioners and researchers [2, 8]. Unfortunately, as most system failures are attributed to sysadmins, solutions are long overdue [11]. In our field studies we observed many situations where the tools and their interfaces failed to support sysadmin work practices, leading to frustration and loss of trust in the tools [8]. Given the business challenges sysadmins face risk is a major issue [8]. Naturally, trust plays a fundamental role in administration practices, in the way sysadmins use and interact with information, people, tools, and computer systems.

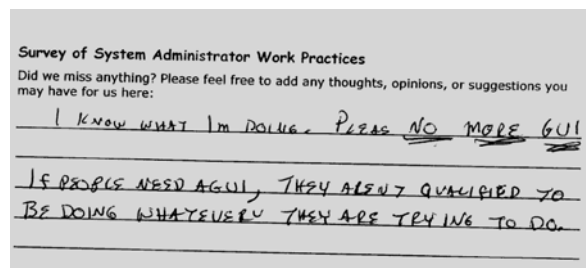


Figure 1. A sysadmin's response to our survey: "I know what I'm doing. Please NO MORE GUI"

In this paper we examine how trust comes into play in the selection of tool interfaces. First, we briefly describe our field studies and survey of sysadmins, and report findings related to interface preferences. Our analysis indicates that trust plays a major role in the tool selection, and cognition-based trust and monitoring are particularly critical factors. Then, we discuss these findings in light of observations from our field studies as we examine the issue of trust in GUIs and CLIs for interaction with complex systems. We conclude the paper with new research directions for interaction with complex systems.

FIELD STUDIES

We conducted six approximately week-long ethnographic field studies in large corporate data centers, studying the organization, work practices, tools, and problem-solving strategies. Over 25 days of observation, we observed 12 different sysadmins of various skills and specializations. Our analysis focused on collaboration and coordination, situation awareness, planning, procedures and workflows, tools, and interaction with complex systems [2, 8].

SURVEY

Based upon insight gained through our field studies, we designed and conducted a survey for a larger set of system administrators where we specifically looked at the issue of trust of the system administration tools interfaces. We recruited 101 system administrators of various backgrounds and roles to participate in the survey through news groups and local and national sysadmin organizations. Each participant was given a gift certificate as compensation. According to the demographics, background, and job information collected, the survey population is fairly representative of the population when compared to very extensive annual surveys conducted by System Administrators Guild (SAGE) that included approximately ten thousand participants [14].

Our survey population was 88% male, 12% female; ages ranged from 25 to 55 with a median of 32; 40% had less than 5 years experience, 35% 5 to 10 years, and 25% more than 10 years; 20% had a high school degree, 62% bachelor's, and 18% post graduate degree.

In the survey we asked specific questions about sysadmins' comparative qualitative judgments of the CLIs and GUIs for system management. These sets of questions concerned the perceived speed, ease of use, reliability, robustness, accuracy, trustworthiness, and likeability. In order to have a better understanding we asked participants to identify the interface they use for typical tasks such as installation, troubleshooting, monitoring, etc. Later in our analysis we also used this to classify participants into CLI and GUI users based on the tools they use predominantly for more than 4 of the 8 common tasks. 13% of the sysadmins were primarily GUI users, 65% were primarily CLI users, and 22% used both equally. Lastly, we asked specific questions related to trust for both CLI and GUI tools. Questions are based on

McAllister's survey, which measures monitoring behavior and cognition-based trust for interpersonal relationships in organizations [9]. Cognition-based trust is "grounded in individual beliefs about peer reliability and dependability" [9] as opposed to affective reasons. We changed the wording of questions appropriately to refer to a tool or characteristics of a tool in place of a person (Table 1), moving the survey from one of human-human interaction to one of human-computer interaction. These questions were repeated for both the CLI and GUI tool identified by each participant as the most used tool for each interface style.

Q1. I have sometimes found it necessary to work around this tool in order to get things done the way that I would like them to be done.
Q2. The quality of performance that I receive from this tool is only maintained by diligent monitoring and tuning.
Q3. Even when others think everything is fine, I know when it is having difficulties.
Q4. I can rely on this tool not to make my job more difficult by bugs created by careless tool development.
Q5. If people knew more about this tool, they would be more concerned.
Q6. I find that this tool does not need to be monitored closely.
Q7. I keep close track of my interactions with this tool, taking note of instances where it does not do tasks as commanded.
Q8. This tool does not have to explicitly notify me for me to know how things are going.
Q9. The software is solid and finely crafted by dedicated developers.
Q10. Rather than just depending on this tool to come through when I need assistance, I try to have a backup plan ready.
Q11. Given this tool's track record, I see no reason to doubt its accuracy and performance now.
Q12. This tool is never deceptive in its presentation of information about the state of the system.
Q13. Other coworkers of mine who must interact with this tool consider it to be trustworthy.

Table 1. Modified McAllister Questions

RESULTS

An analysis of the comparative qualitative judgment questions suggests that most sysadmins in our survey consider CLIs to be more reliable, robust, accurate, trustworthy, and faster when compared to GUIs (Figure 2). While there is a split with respect to the relative ease of use of the tools, interestingly CLIs are considered to be more likeable compared to GUIs by the majority of the system administrators. An ANOVA analysis, where participants are classified as primary CLI, or GUI users, suggest that CLIs are considered to be faster ($F(1,77)=4.36$, $p=0.029$), easier ($F(1,77)=6.77$, $p=0.011$), more reliable ($F(1,77)=4.38$, $p=0.040$), robust ($F(1,77)=3.70$, $p=0.058$), accurate ($F(1,77)=3.80$, $p=0.055$), trustworthy ($F(1,77)=9.06$, $p=0.004$), and likeable ($F(1,77)=5.43$, $p=0.022$), more so for CLI users than GUI users.

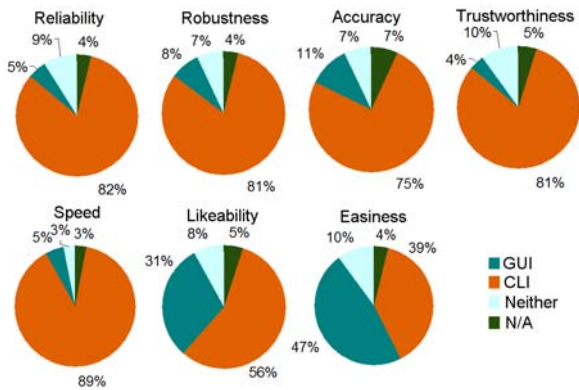


Figure 2. Comparative qualitative judgments of CLIs and GUIs for system management

In a pair-wise comparison T-Test, 10 out of the 13 trust and monitoring questions had statistically significant differences. GUIs elicited less trust than CLIs and required more monitoring than CLIs as shown in Figure 3 (* marks statistically significant results where $p < 0.05$).

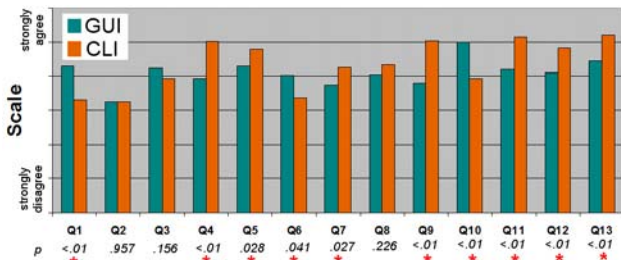


Figure 3. Trust and Monitoring Questions Results

Finally, we used a repeated measures ANOVA on the trust questions, a one-way ANOVA on each trust question comparing GUIs vs. CLIs, and an exhaustive correlation test with all survey questions. Some of these findings are summarized in Table 2.

Finding 1: CLIs are perceived by these sysadmins as deserving more cognition-based trust and less monitoring than GUIs. ($p < 0.05$)
Finding 2: GUI-users are more likely to not depend upon their GUI tool to come through when assistance is needed and more often try to have a backup plan ready than CLI-users. ($p < 0.05$)
Finding 3: GUI-users are more likely to keep track of their interactions with their GUI tools than CLI-users. ($p < 0.05$)
Finding 4: CLI-users report that their coworkers who must interact with their CLI tools consider them to be more trustworthy than GUI-users report their coworkers who must interact with CLI tools. ($p < 0.10$)
Finding 5: The fewer the years working as a sysadmin, the more the sys admin believes that the command line tool is not deceptive about system state. ($r = -2.96, p < 0.01$)

Table 2. Summary **Trust Monitoring Findings**

DISCUSSION

We found that trust and monitoring are critical factors in deciding between the CLI and GUI styles of interaction for system management tools. Our survey also shed some light onto how trust comes into play in the selection of

tool interfaces. Before examining the issue of trust in tools we will discuss the human-human trust literature.

Trust among people can be defined as the expectation that arises from within a community of regular, honest, and cooperative behavior, based on commonly shared norms on the part of members of that community [5]. Trust is an important component of many social and business relationships, determining the nature of the interactions and people’s expectations [5]. Trust helps to reduce the overwhelming complexity of the social environment at the expense of vulnerability on the part of its participants. Barber examined the multi-dimensional nature of trust and recognized three dimensions of trust as: persistence of natural and moral laws, technically competent performance, and fiduciary responsibility [1]. Muir also built a framework for analyzing trust in human-machine interactions by crossing Barber’s dimensions with Rempel et al.’s taxonomy of trust development, including predictability of acts, dependability of dispositions, and faith in motives [10, 12]. Here we look at trust using the dimensions of integrity, transparency, and consistency roughly following Rempel et al.’s taxonomy.

Arguably, we look for similar trustworthy qualities in our tools as we do in people. Based on our results, we can observe the features of trust as it occurs among people also occur in our interactions with tools. For example, Finding 4 suggests that trust is transitive. CLI users consider their CLI-using coworkers to be trustworthy, more so than GUI users whose coworkers use CLI tools.

With respect to dimensions of trust we clearly see integrity, consistency, and transparency come into play. One of the survey respondents wrote, “I prefer the cli. These tools seem to be the most truthful and accurate for administration. gui’s seem to be buggy, and do not update state as often.” Finding 2 suggest that even GUI users do not depend on their tools and usually have backup plans ready. In one of our field studies, the administrator - unsatisfied with the process status information in the GUI - resorted to the CLI to discover whether some application processes did not actually start.

The integrity issue is closely related to that of transparency. Many sysadmins consider GUI tools to be more deceptive about the system state (Q12, Figure 3). In fact, Finding 5 suggests this may also be true for CLI users, especially as the sysadmins become more experienced. In one situation during our field studies a sysadmin told us: “You don’t want to touch the GUI when it is doing its thing.” Such comments stem from the fact that when GUIs run it is usually not clear what is happening under the covers. One of the sysadmins wrote in our survey, “I tend to learn the guts of things in a CLI as close to the heart of the matter as possible, and then translate it into a GUI... so I can stay mentally consistent with my other high level business tasks, and I don’t tolerate inconsistencies.”

Consistency is also an important issue. Finding 3 suggests that GUI users need to keep track of their interactions with the GUI tools, more so than the CLI users on the CLI tools. One of the participants seeing the trend for more GUI tools replacing CLI tools commented, “The biggest problem I have with system stability is software vendors’ insistence on converting known good utilities into java tools, which only makes them slower and less reliable.” Another wrote, “GUI tools have been built upon the command line interfaces so its always better to know the command lines whether you use GUI or not.”

Communication plays a central role in the development of trust between people and tools as much as in trust among people. Trust develops over time as participants engage in effective dialogue. Brennan argues that human-computer interaction bears many similarities to conversation regardless of whether the currency of interaction is icons, text, or speech [5]. Failure in reaching common ground [3, 4] may lead to loss of trust. We argue that the complexity introduced due to the work environment further necessitates effective conversation between people and computers, especially for power users such as sysadmins. Trust is critical as a simplifier of the complex blend of interactions among people, information, and systems.

How do we enhance GUIs to mediate more effective dialogue? GUIs support higher level interaction than most CLIs, but this can be problematic because of hidden complexity. CLIs offer consecutive commands and system responses that more closely resemble conversation, but context is not carried over to new commands. Further research must be conducted to find appropriate design guidelines to resolve these problems, particularly for human interaction with complex systems.

CONCLUSION

Trust is emerging as a potentially critical factor in the adoption of technology as it affects perceptions of ability and benevolence. Others have looked at trust in e-commerce [13] and freeware contexts [6]. In this paper we examined trust in the selection of tool interaction styles for system administration.

The predominance of GUI administration tools suggests that developers have believed that the usability of such tools can be improved in the same manner as for any end-user: adding a GUI and simplifying the presentation. Admins are not typical end-users, however, it is clear that they must be provided clearer models of the systems at the risk of making their interactions perhaps more complex than in more traditional GUIs. We believe, however, that this complexity can in fact be reduced through trustworthy interfaces that support effective conversation whether it is a CLI or GUI.

ACKNOWLEDGMENTS

We thank Eben Haber for his careful review of this paper.

REFERENCES

1. Barber, B., *Logic and the Limits of Trust*. Rutgers University Press, New Brunswick, NJ, (1983).
2. Barrett, R., Chen, M., & Maglio, P. P. *System Administrators are Users, Too: Designing Workspaces for Managing Internet-scale Systems, Ext. Abstractions CHI 2002.*, ACM Press (2002), 1068-1069.
3. Brennan, S. E., The Grounding Problem in Conversations With and Through Computers, In S. R. Fussell & R. J. Kreuz (Eds.), *Social and Cognitive Psychological Approaches to Interpersonal Communication*. Lawrence Erlbaum, Hillsdale, NJ, (1998), 201-225.
4. Clark, H. H. *Using Language*. Cambridge University Press, Cambridge, UK, (1996).
5. Fukuyama, F. *Trust: The Social Virtues and the Creation of Prosperity*. Penguin Group, London, UK, (1995).
6. Gefen, D., Building User’s Trust in Freeware Providers and the Effects of this Trust on Users’ Perceptions of Usefulness, Ease of Use, and Intended Use, Ph.D. Dissertation, Georgia State University, (1995).
7. Gelernter, D., *Machine Beauty: Elegance and the Heart of Technology*. Basic Books, New York, NY, (1997).
8. Maglio, P. P., Kandogan, E., & Haber, E.. Distributed cognition and joint activity in collaborative problem solving. *Proc. of the Cognitive Science Society*, (2003).
9. McAllister, D. J. Affect- and Cognition-Based Trust as Foundations for Interpersonal Cooperation in Organizations. *The Academy of Management Journal* 38, 1, (1995), 24-59.
10. Muir, B. M., Trust between humans and machines and the design of decision aides. *International Journal of Man-Machine Studies*, 27, (1987), 527-539.
11. Patterson, D., et al. *Recovery-Oriented Computing (ROC): Motivation, Definition, Techniques, and Case Studies*, Technical report CSD-02-1175, Computer Science Dept., Univ. of California, Berkeley, (2002).
12. Rempel, J. K., Holmes, J. G., Zanna, M. P., Trust in close relationships, *Journal of Personality and Social Psychology*, 49, (1985), 95-112.
13. Shneiderman, B. Designing Trust into Online Experiences. *Communications of the ACM* 43, 12, (2000).
14. System Administrators Guild (SAGE) Salary Surveys, http://sageweb.sage.org/jobs/salary_survey/