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Int. J. Human-Computer Studies 63 (2005) 410–421
International Journal of Human-Computer Studies
www.elsevier.com/locate/ijhcs

Fostering motivation and creativity for computer users

Ted Selker*

MIT Media Lab, 20 Ames Street, Cambridge, MA 02139, USA

Available online 5 August 2005

Abstract

Creativity might be viewed as any process which results in a novel and useful product. People use computers for creative tasks; they flesh out ideas for text, graphics, engineering solutions, etc. Computer programming is an especially creative activity, but few tools for programming aid creativity. Computers can be designed to foster creativity as well. As a start, all computer programs should help users enumerate ideas, remember alternatives and support various ways to compare them. More sophisticated thinking aids could implement other successful techniques as well.

Most computers are used in solitude; however, people depend on social supports for creativity. User scenarios can provide the important social support and gracious cues normally offered by collaborators that keep people motivated and help them consider alternatives. People also use computers to build community and to communicate. Computers should also support and filter these potentially creativity-enhancing communication acts.

User-interface designers are so busy exposing features and fighting bugs that they might ignore their users' needs for motivation and creativity support. This paper develops the notion that creativity and motivation enhancement can easily be aligned with the design of high-quality human–computer interaction. User interface toolkits and evaluations should include support for motivation and creativity-enhancing approaches.

Keywords: Communicate; Communication; Community; Computers; Creative; Creativity; Creativity-enhancing; Design; Engineering; Filter; Graphics; Human–computer; Idea; Interaction; Motivation; Product; Programming; Social; Support; Text; User interface

*Tel.: +1 617 253 6968; fax: +1 617 258 0910.
E-mail address: selker@media.mit.edu.

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doi:10.1016/j.ijhcs.2005.04.005

1. Introduction

Dictionaries define "creativity" with words like "originality, expressiveness and imagination." To take this creativity to practice requires the word "create," which is defined as "causing to exist" or "bringing into being." Creativity is a broad and important area (Heleven, 2003) bringing new ideas and improvements to people's lives. While some still hold that teaching creativity is dubious (Carles, 2003), Nickerson's work reports on teaching and measuring creativity improvement over an extended period of time. He demonstrates that people continued using the acquired creative process and even applied it in new domains (Sternberg, 1999).

More colloquially, teaching creativity has become an industry. Self-help books on how to be creative have abounded (Heleven, 2003). Edward DeBono, the inventor of the term "lateral thinking," alone has published dozens of books on the topic. His consulting and educational workshops on creativity are said to be inspiring.

Possibly no one is more cited for his writing on creativity than Mihaly Csikszentmihalyi, the inventor of the idea of flow as it applies to creativity (Csikszentmihalyi, 1996). Computerizing creativity might well start from a description of creativity such as Teresa Amabiles, that breaks it into parts that have been validated in experiments (Amabile, 1982). The approach is based on a set of four components: domain relevant knowledge, creative skill, and motivation, which all interact with a fourth element, the external work or social environment to contribute to creativity. Dozens of stand-alone software products promote theories of how to create ideas or improve inventions (Heleven, 2003). Can these not be validated and integrated into software workflow products?

Computer interfaces are typically judged on many factors such as power, elegance, simplicity, ease of use and learning. They are judged on what they allow a user to accomplish. Some people believe that virtuoso performances require skill and practice in their own right. Do good tools have to be difficult to learn to use? Maybe not; many modern systems allow a user to do something fancy with a little bit of training. Spreadsheets are legendary for their ability to simplify the act of performing computations (Brown and Gould, 1987). Good functional user interface is taking the tool out of the task. If the user interface can avoid being the focus of attention, the user can focus on the goal (i.e. writing the paper, making the phone call, etc.). Auto-complete techniques such as remembering ones name or other information to fill in a form can be huge time savers. If the interface cannot go away, it is judged on its naturalness, or ability to look and act like a user expects. Naturalness can be supported by direct and simple manipulation and connections between visual or physical parts. Ease of learning can be supported by matching the cognitive model that people inherently have. It can also be supported by making things look similar to things that the user already knows how to use (Douglas and Moran, 1983).

User interfaces are also judged on the quality of the user interface's teaching materials. If the tutorial is captivating and instructive, or if the help system is easy to stumble around to solve problems with, the user will be more likely to believe that the system has a good user interface. While the ergonomics community has long considered fatigue as an important part of ergonomics, it has not played a central

role for the human–computer interface community. Maybe making user interfaces that work has been hard enough. Still, fatigue and other motivation factors can distract people from being creative. Productive non-intrusive interfaces can allow people to focus on their creative tasks.

Other workflow techniques can aid whatever creative process one uses as well. The ability to start and stop secondary tasks is important to creative pursuits (Csikszentmihalyi, 1996). The cost of changing approaches should be low, too. In fact, the changing approaches can increase concentration as well (Arroyo and Selker, 2001). The spreadsheets mentioned above are also famous for giving people an ability to compare results in what-if scenarios (Brown and Gould, 1987). Allowing a person to pick up where they left off allows people to compare and try different things. It is useful to be able to share parts with others for assistance and criticism, and to evaluate creative possibilities.

The remainder of this paper gives examples of features that designers can add to human–computer interface that improve users' motivation, engagement and ability to be creative.

2. User interface flow

Possibly the most important creativity enhancers include recognizing and promoting a state of flow, the feeling that everything has useful momentum. As partners, the computer should take on decisions the user cannot assess, save error codes, safeguarding early and often against data loss, etc. The computer might also take care of problems that are hard for the person to review and consider. Years ago we had to understand the partitioning of a computer disk; today, disk controllers make such decisions by themselves. Support systems should be able to help people in obvious need. A computer can notice that a user has not responded for a while: are they having difficulty or have they left the computer? What if they are working on something for 2 h without stopping: should the system encourage a break? Should responding differently or with fatigued responses even to familiar decisions be a cue to give a chance to take a break? A computer could notice if a person is unpractised at some procedure and encourage review for quality. If a person shows competence the computer should not inhibit his/her progress. The computer can play a part to keep people in their best role for succeeding at thinking and solving problems.

3. Setting stage for creative work

Many factors can help set up a creative context. People create special physical settings, go to special workshops or run special software to get them in the mood to be creative. These approaches can be extremely productive and useful for the right person in the right situations. A number of assumptions that standard software designers include can also thwart or disable creativity. If interface designers explore how to stop thwarting motivation and creativity and include the best-known tools

and techniques for enhancing creativity, they will most certainly improve productivity.

The software shelves are full of programs that promote themselves as creativity tools (Heleven, 2003). To the extent that these tools incorporate techniques that improve people's creativity, they should be designed to be integrated into all applications and computer work settings.

Unfortunately, people will not always be interested or willing to stop working to start up a creativity-enhancing tool. These tools will need to be non-distracting for wide acceptance. We must search for motivational and creativity-enhancing activities that can be integrated into applications and that do not deter workflow. A recent special issue on creativity in HCI includes writing on the topic (Burleson and Selker, 2002).

Still, some approaches to getting people to be creative just do not work. I once went to a 5-h brainstorming session with some of the most creative people I know. We had a fancy setting; we had flown in from all over the map. It all started with drinks with the publishers the night before. We were told not to talk about design there; we would tomorrow, but was there too much delay at doing what we had come for? In the morning we went to a famous and fabulous setting, breakfast was exquisite, the presents were generous. A fancy facilitator set up microphones in front of us all. Testing the microphones took 20 min, but was this too distracting and built up? Taking a group photo shot took 45 min, but did this set a practice for not sharing ideas? The facilitator tried to structure the conversation, but did this take the responsibility and power away from the creative? Then lunch came, a microphone-off lunch, but did this reinforce that we should stop thinking some of the time? In all, no one played his or her best cards. The discussion was too distracted by the set-up. The overly eager facilitator inadvertently presumed hierarchy which added extra protocol. Working together on a project or meeting in an unstructured social venue routinely brings out wonderful discovering conversations in these people. In this structured moment they fell back on their stock phrases.

This section has argued that processes can help and others that definitely thwart the creative experience. A supportive environment, time to be creative and the expectation of success are necessary to the creative process. The next section describes areas where user experience techniques in computers can by themselves cause these problems.

4. Stumbling blocks

An idea has to be captured and expressed to be considered. Most people have had the experience of forgetting what they wanted to say when someone else chose that moment to talk. Software should not "interrupt" when a person is trying to express an idea either. Having to respond to some computer message, start up an application, or press the Alt–Esc chord key 3 times might be as bad as your listener saying that they need to set up microphones for 20 min first, as in my ill-fated brainstorming meeting. Having to start a program, change modes, and go to another

part of the screen all take attention. This diversion can disrupt the flow and documentation of ideas.

Some people know about cutting text with the Control-C command from years of text editors that have used this command. Remembering and using this familiar and simplifying act is not a distraction to me. If a person uses a command all the time, their consolidated memory for it will allow them to type it faster and with less attention. Regardless of how easy and recognizable each step is, it adds to the complexity. One email system that I use requires multiple times the number of selection tasks of other similar programs. A task model such as GOMS show these extra steps as distracting (Card et al., 1983). Recalling and entering an uncommon command is more distracting than just recognizing and selecting it (Klatzky, 1980). Unless an expert remembers what and where commands are, having to remember them can inhibit workflow.

Classifying and organizing things can be helpful, but where should they be located to be remembered? Early hypertext experiments found people's focus on classifying their work distracted them from doing the work (Foss, 1989). Computers are good record keepers; ideas and possibilities are the central elements that need to be acquired for the creative effort. All computer programs should give their users a way of recording notes about ideas and possibilities and knowing where notes about are put. To retrieve and use a note one must know that they have it. Mechanisms for creating new ideas, putting them in new places, and finding them again must be good enough so as to not distract one from the memory itself.

Undo is an old gripe. Ever since the text editor was invented, suggestions for being able to revisit every change ever made to a document have been a dream of many. Most computer clipboards do not have structure or deep backup yet. In fact, I lost part of this paper due to a simplistically designed text editor backup approach. A set of notes that can be scrolled through is a simple way to remember what one was thinking before they changed their mind. Physical paper and whiteboards record the complexity of conversations getting messy when people keep thinking. The layers of alternatives that are crossed out and moved tell a story. This story of what the current stage of ideas are gets so important that people become reluctant to throw away the notepad or erase the white board. Some people keep a current status of the whiteboard on a wall for months. Versioning text editors such as PEdit (Kruskal, 1984) have been available but not highly deployed until Microsoft Word 6. PEdit created different versions of documents for different purposes. It allowed a version to be set up for different compilers or versions of a paper. When a person changed something with PEdit, it would change the part of the document in each appropriate document. Such a mechanism allows a person to make alternative versions without committing to eliminating others. It also allows new ideas to be put off to the side for revisitation. While Microsoft Word does allow different people to use different colors, these changes are not revisitable when approved and it does not support different like versions that are linked together to allow people to compare ideas.

The creativity industry advocates brainstorming prosthetics; these come in the form of lists of steps to go through or pictures and words to help expand ones thinking on a topic. An on-line thesaurus is such a tool. Outliners have been helpful

to some, brainstorming tools to others, focus lists to others still. Now people have the Internet, and ask it questions at will.

This section highlighted some standard software user interface features that help people try ideas. We turn off extra programs and "computer interruptions" to be creative, we record extra versions of ideas and documents to revisit partial ideas and we search through thesauruses and the internet to help us seed new ideas and alternatives. The rest of the paper will focus on how different human and computer capabilities can be useful in the quest for more self-motivating and creativity-enhancing interfaces.

5. Cognitive science considerations

What are the precursors to motivational and creative success in a task? The task must be attainable first. A good user interface should attempt to take the tool out of the task. It can be demotivating to spend a long time finding a pencil or text editor when trying to note down an idea. Perceptual sensory, precognitive, cognitive, ergonomic, behavioral and social abilities all impact human performance (Klatzky, 1980). Designers need to make software to take these human constraints into account.

5.1. Perception effects creative potential

What people see is easier to keep in mind. Systems that require extra effort to find or notice things are distracting; time used for concentrating on perception borrows from cognitive tasks. Sensory limitations are in every interface decision from display contrast ratio to font design and even the shape of typing keys. One hundred years of literature had not noticed a major improvement that was possible with rate control devices; the IBM TrackPoint (Rutledge and Selker, 1990) is at least 20% faster at selection than other joysticks because it uses a cognitive model of how fast eyes track. This literally translated into 20% more text editing in the same time. The ability for the muscle to sense movement matters too. People cannot function productively below their proprioceptive control limit. A model of eye–hand coordination indicates that movement might give important proprioceptive feedback. A compliant rubber top control surface moved with a little with pressure. A compliant rubber top control surface that flexed with a little pressure made a 15% improvement in the speed that a novice could make selections with TrackPoint.

5.2. Ergonomics effects creative potential

It takes more effort to acquire and use something that is out of reach. The TrackPoint is placed in the middle of the keyboard as a direct consequence of literature that made it obvious that a person spends almost 2 s switching from a keyboard to the mouse and back again (Rutledge and Selker, 1990). The TrackPoint

saves most of a second over reaching for a track pad. In this way it can reduce time of mixed typing and pointing activities like text editing as described above.

The arrangement and distance between physical things makes a big impact on mental difficulty. Even if someone has a great comment to contribute, they might not ask for the microphone from the back of an auditorium. At the New Paradigms for Using Computers conferences we dispensed a computer tablet with drawing and text capability that got passed around the auditorium (Selker, 1998b). This allowed anyone to present imagery or text comments and annotations to another's talk on a screen. In several instances, this tablet allowed an audience participant to clarify a point or add a different perspective to the conversation. One particularly difficult moment was gracefully salvaged as a speaker turned to controversial politicised topics. A cartoonist in the audience softened the moment, adding mirth and helping the speaker refocus on the future of computer interaction. These examples of interaction design show that allowing and encouraging ideas to be presented at the moment of relevance can make a positive impact.

The ergonomics of audience participation in an auditorium are interesting. However, the simpler ergonomics issues in positioning information on a screen might benefit people more. The COACH help system, for example, specifically positioned local information close to the cursor and more general information farther from it (Selker, 1998a). By eliminating the physical difficulties, user interfaces can reduce the effort of presenting ideas. Such ergonomics factors are important to consider in designing interface tools to express ideas.

5.3. *Precognitive and creative potential*

User interface design can carelessly add extra mental effort when it is not necessary. Some things are recognized by the mind without even taking one's attention. Regardless of what the user is doing a blinking cursor distracts the eye. Dropped shadows on menus can be recognized much faster than normal picture frame style bezels (Enns and Rensink, 1990); several precognitive perceptual images work this way. In the OS/2 Smart Guides system, we used see-through interface techniques to focus attention on the parts of the interface where decisions have to be made (Kelin et al., 1997). By understanding the precognitive literature, designers will be able to reduce distraction and allow creative people to be attending to problems and opportunities.

5.4. *Cognitive considerations effect creative potential*

User interfaces that require too much short-term attention are difficult to use. The limit to how many things can be remembered at once is often covered by the legendary 7 ± 2 (Miller, 1956). Just as with physiological psychology issues, the limits of cognitive ability must be respected to allow people to learn and remember. For example, user interfaces that inadvertently prime a user with a point of view might stop other ideas from being considered (Klatzky, 1980).

A study revealed that text editor user interface issues could diminish quality of creative writing (Rosson, 1983). A group was given a command-line controlled text editor that only allowed them to edit the text. Another group was given a graphical user interface based on What I See Is What I Get (WISIWIG) text editor which allowed them to format as well as edit their text (the group with the simple text editor wrote better and longer stories). The simpler text editor seems to have allowed users to write better. Although the group with the WISIWIG editor probably made and learned to make better looking papers this was not discussed in the study. If this was a creative writing exercise, the straight text editor was probably more appropriate. If learning to layout a paper is important, the text-only editor is not useful at all. Users must understand where the creative interest is to choose tools that allow them to focus on their goal.

5.5. *Behavioural considerations effect creative potential*

Most people's offices are adorned with mementoes to make them feel comfortable. These belongings might make them feel ownership but can also help them take mini breaks and have outlets for releasing tension. Pictures on the wall of a simple clean office draw people's attention to them. The squeeze ball and a small fountain can also draw attention in a non-demanding way to be used to take a mini break without losing focus altogether. A nice place to sit with a clock to enjoy a view with a pad of paper nearby allows a person to focus on writing or drawing on the pad as an outlet. In my lab, we are beginning to study how to replace the way a cigarette can serve such purposes. Computers should afford users mini-breaks too. Unfortunately, these backdrops when in place on a computer are often more distracting than a short puff on a cigarette a writer may have taken at a typewriter in a old movie. Windows popping up with animations in them, games that need to be completed if one starts them are not being respectful of a person's time and goals. Even the ''wallpaper'' on graphical interfaces can distract users from finding the icons they are looking for on the screen. Designers can make more computer activities that can be non-distracting background activities.

So many books have been written on procrastination that it is surprising that the computer buyer is not showered with anti-procrastination software. By watching the pattern of use, a computer could interpret aspects of a user's intentions (Burleson and Selker, 2000). A computer system Cheese watches mouse motion to tell if a user is looking at a web page that they have been at before (Lockerd and Selker, 2002). Such mouse analysis and keystroke analysis could be directly focused on procrastination, over editing, or changing tasks.

5.6. *Social considerations effect creative potential*

People do better with social feedback. Since there are such strong connections between social feedback and people's ability, these are a prime target for making active user interface aids for motivation and creativity.

It seems that telling a person that they are doing well part way through a project improves their resolve to finish it (Nass and Reeves, 1996). It is quite possible that the most important thing for me to finish this paper was my wife leaving and coming back several times an hour. The computer was encouraging me to pay attention to its distracting maintenance problems; luckily my wife was focusing my attention on the creative task at hand. Instant messaging and other social computer games can be a support or a distraction for people trying to create something. As with many things, the encouragements we seek can themselves turn into a diversion.

Instant Messaging, email, and Internet searching can help a person expand their thinking and search for a solution. They can also distract a person and make it harder to focus. Tools to help people know when they are getting distracted are starting to exist.

DriftCatcher (Lockerd and Selker, 2002) classifies email based on social relation and succeeds at getting people to focus on the relationships they want to improve. Empathy buddy gives feedback on emotional tone and helps a person notice the tone they connote in their writing (Lieberman et al., 2003).

As a bad speller and syntax lightweight, Microsoft Word is a great mentor. George Heidorn worked on computerized syntax improvement technology as a graduate student. He improved it at IBM and drove it into the mainstream at Microsoft (Heidorn et al., 1993). If the computer can mentor, why can it not collaborate? Systems such as COACH, in which a user's own mistakes are shown to them when they make them again, can act as a colleague that notices and works with users to accomplish things (Selker, 1998a).

Motivating and creative tasks must take into account social expectations. I was trying to write this paper, the computer had some problem. I spent a better part of a day fiddling with the buffer size and error exceptions, etc. My wife pointed out that I had accomplished nothing; by working with her for a few moments I was able to describe the paper. She went away, she came back and asked me for an outline. By giving me social support and focus, she was able get me to work on it. Simple approaches to this can make a huge difference. The ability for a person to feel judged by a computer is well documented (Nass and Reeves, 1996). People are less willing to communicate something to a computer that they perceive as a judgement about it. Positioning the computer's implied persona could be used to improve people's ability to feel that they can use it to be creative. It is possible that a creativity branded computer, one that purports to have easy to use tools, and goes out of its way to present alternatives, will make people act more creative when using it (Burleson and Selker, 2002).

This section has pointed to the ways computers can support the perceptual sensory, precognitive, cognitive, ergonomic, behavioral precursors to creativity. Distractions come in all forms; latency and motor control, awkward ergonomics, perceptual and memory tests in interface, clutter, and even poor pacing and timing of feedback block creative people. Designers need to make software to take these human constraints into account.

6. Discussion

The difficulty of changing and learning new tools can be distracting. Many expert programmers spurn programming supports; choosing a command line and a simple text editor to write and debug programs. Toolmakers must make program editors, steppers, debuggers and visualizers, which allow programmers to visualize, add to and change programs in any language. Toolmakers must make languages that allow users to extend their applications to work well with other languages and programs. Mainstream computer users have given up on computer programming for the slow brittle communication tool it can seem to be. When can designers make the planning and organization of problems that programming is, feel creative without total immersion style commitment to it?

A tool is something that allows people to do tasks faster or better than they could without it. Computer application designers have not necessarily tested or even know how to test the effectiveness of their "productivity tools." Any toolkit to help developers incorporate creativity and motivation into computers needs to help them test that their system does help their users. The developer needs to test and know that their work helps users focus on their problem, consider ideas, focus their attention, change directions, seek and consider criticism, etc. Let us praise a product manager that gives the world a computer tablet that is easier to use than paper, a digital cable TV system that is easier to find one's way around than analog TV surfing. Let us be nostalgic for a web programming approach that did not require us to keep an alphabet soup of tools and protocols in mind to be productive today. We must reduce the memory load for people to be creative.

Computers were designed to extend human analytical and creative power. Even the fact that the computer was a valuable resource used to lend credibility and prestige to the people in a project. The participant's motivation was piqued. The affirmation of prestige of getting to use a computer is no longer such a motivator.

Above, we described the difficulties of intermixing writing, editing and formatting. Still, computer writing systems have an intrinsic benefit in the reduction of the stumbling block of writing a draft. Outliners and spreadsheets have without question given users perspective and the ability to change what they are doing to try alternatives during the creative process. Today's computer programs from WISIWIG interfaces to on line thesauruses already give us many tools and approaches that help overcome cognitive stumbling blocks, but are still far from what they could be.

We expect creativity support tools to help developers know how long to wait to generate a graceful pause in a conversation, help show alternatives, help people compare ideas, find resources annotate actions and evaluate their work (Miller, 2002). Such tools should also be careful to allow a user to keep structure, communicate appropriately and notice how much time or other resources they are committing to an idea. Sometimes the most important motivation and creative inspiration will be to look for collaborators. A creativity enhancing toolkit needs to help in the evaluation of when to encourage a person to enter a social partnership for increased creativity as well.

The search for improved cognitive prosthetics, just as the search for all tools, is endless. The paper is meant to be motivational not exhaustive. This is the beginning of an era in which computers become partners in peoples work. We hope that this paper helps computer application developers' focus on the emotional and cognitive precursors to creativity, the highest human cognitive process of all.

This paper is a call for motivation and creativity enhancing toolkits for software developers. It has presented some approaches for improving computer user motivation and focusing on the creative process. These approaches hold clues to the elements that should be included in the tool kits. The paper has taken a walk through human capabilities that user interface designers consider in their design. The conversation has been on what systems do to de-motivate or distract users from creative processes, and what could be done do to enhance these processes.

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