

Theorizing the Relationship between Affect and Aesthetics in the ICT Design and Use Context

Ping Zhang
Syracuse University
pzhang@syr.edu

Abstract

With an increasing interest in both affect and aesthetics in the context of information and communication technology (ICT) design and use, there is a timely need to provide a theory based understanding of these concepts and their relationships. In this paper, we point out some confusion as shown in the literature and provide a theory based understanding of the concepts and their relationships. Such an understanding can eventually provide practical suggestions on researching affect and aesthetics in the ICT context and suggest researchers to expand the coverage of aesthetics concept from focusing primarily on pleasantness or positivity to a broader coverage indicated by affect's structure.

Keywords

Affect, aesthetics, information and communication technology, theory.

1. Introduction

Studies in Information Systems and Human-Computer Interaction (HCI) fields have gone through a number of milestones including the emphases on robustness, functionality, usability, and recently aesthetics and emotional design of information and communication technology (ICT). It has become a well known phenomenon that “what is beautiful is usable” (Tractinsky et al. 2000); “attractive things work better” (Norman 2002); and “time flies when you’re having fun” (Agarwal et al. 2000). It is recognized that designing ICT that can touch humans in sensible and holistic ways is essential in ensuring a successful and satisfying interaction experience.

Aesthetics have been studied in various disciplines for a long period of time. The concept is sometimes used to describe a sense of pleasure or beauty, although it is realized that its meaning is much broader including any sensual perceptions (Wasserman et al. 2000). In general, the movement from functionality and usability to aesthetics has signified a movement from being utilitarian or instrumental orientation to experiential orientation and from a cognitive paradigm to a more affective centric paradigm (Norman 2002, 2004; Zhang et al. 2004, 2005).

A careful review of aesthetics research in the ICT related literature reveals a number of concerns. First, the definitions and understandings of aesthetics related concepts are varied. For example, we have seen studies on visual appeal, attractiveness, emotional design, beauty, perceived aesthetic quality, aesthetics interaction, hedonic usability, hedonic quality, affective quality, and affective reactions, among others. It is unclear whether these studies are all about aesthetics in

HCI, and how these concepts are related to each other. Second, there is a lack of agreement and a lack of confidence on how to measure aesthetics related concepts. Should aesthetics be a one-dimensional construct, or two dimensional? Should it be measured with multiple items or a single item? Third, it is unclear what would be the “goal” of aesthetic design. Is being beautiful the goal? Or is it the means for a higher goal? Is being attractive something ICT designers should strike for, and if so, why? Fourth, there are some anecdotic claims of aesthetics’ effects on interaction that lack of scientific evidence support. Although a number of empirical studies provide us with solid evidence, the general claims are broader and some have little root either in theory or in empirical evidence. Overall, these concerns impose limitations on further development of research in this area. They also restrict the guidance on ICT design and practice. These concerns indicate a lack of theoretical orientation on aesthetics studies in the IS and HCI fields.

In this conceptual paper, we address some of these concerns. Specifically, we detail the confusions in the literature. Then we attempt to provide a theoretical examination of aesthetics from an affective perspective. This perspective anchors aesthetics to a more fundamental human aspect, affect (including emotion), so much that aesthetics itself is not the goal but rather the means of effective and desirable ICT design that has positive effect on users’ affect. This perspective suggests expanding the coverage of aesthetics to include more than just pleasantness.

Aesthetics and affect are often studied separately, thus are often found in different literatures or disciplines. Yet, as we will point out later, they should be closely related to each other, especially from a human motivational point of view. In this paper, we first visit the foundations of aesthetics and affect independently, combined with reviews of studies in the ICT context. Then we present a theoretical linkage between aesthetics and affect.

2. Aesthetics

Aesthetics is a branch of philosophy and is often associated with art. Aesthetics is also found in a broad range of disciplines and in many aspects of human lives. Aesthetics as the object of study has a long history. It is beyond the scope of this paper to revisit its historical development. Lavie and Tractinsky provided a good review of the historical development of aesthetics and different approaches to studying aesthetics including studies in HCI (Lavie et al. 2004). Interested readers can also learn more about aesthetic computing, a broader sense of aesthetics in art, design, computer science, and mathematics by reading a set of collected articles (Fishwick 2006). In general, aesthetics is considered to be an elusive and confusing concept (Lindgaard et al. 2006). It has been realized that studies on aesthetics in HCI have taken different notations of aesthetics (Udsen et al. 2005).

One of the most debated issues in aesthetics studies in general and in the ICT context in particular is objectivity vs. subjectivity. It is often found in the literature that aesthetics is treated as either objective or subjective. Aesthetics or beauty is the quality (or aggregate of qualities) in a person or thing. This means aesthetics lies in the person/thing or object (including an artifact) in one’s environment. An object or artifact in one’s environment must have certain features or characteristics to reveal its inherent quality, or with aesthetic potential. Such properties or attributes exist regardless of whether they are perceived by people or agreed upon among people. This is the objectivity view. Aesthetics is also concerned to have an effect on the senses of a

perceiver. In other words, aesthetics is appropriated by observers in their own social, cultural, and historical standard as being aesthetic (Dewey 1987; Shusterman 1992). The same aesthetic quality of an object may have a different effect on different people. This is the subjectivity view.

In the ICT context, both views have been studied. The same term “aesthetics” may imply either objectivity or subjectivity (for example, Hartmann et al. 2007). Several related concepts are developed to indicate the explicit meanings of subjectivity, such as “aesthetic perception” (Tractinsky et al. 2006), “perceived visual aesthetics” (Lavie et al. 2004), “perceived aesthetic value,” and “aesthetic experience.” There are several other related concepts such as perceived visual appeal/attractiveness (Fernandes et al. 2003; Lindgaard et al. 2006; Tractinsky et al. 2004; van der Heijden 2003), perceived aesthetics (Ben-Bassat et al. 2006; Tractinsky et al. 2000), and hedonic quality (Mundorf et al. 1993).

In the ICT context, aesthetics and its related concepts have been measured in different ways that reflect fundamentally different conceptualizations and operationalizations. Researchers have recognized that some studies treat aesthetics as a cognitive concept and some as an affective concept (Lindgaard et al. 2006).

At the operational level, aesthetics has a number of treatments. For example, it is treated as a unidimensional construct with multiple measuring items (Schenkman et al. 2000; van der Heijden 2003). It is also measured with visual appeal as a one item measure (Lindgaard et al. 2006; Tractinsky et al. 2006). Most noticeable difference is a recent effort in developing measures of perceived website aesthetics where Lavie and Tractinsky identified a two-dimensional structure (Lavie et al. 2004): the classical aesthetics refers to orderliness in design, including descriptions such as “clean,” “pleasant,” “symmetrical” and “aesthetic;” the expressive aesthetics indicates designers’ creativity and originality, and can be described by “sophisticated,” “creative,” uses special effects” and “fascinating.” This measure, however, is not without criticism (Lindgaard et al. 2006).

3. Affect

Affect is a general term for several related but different concepts and normally represents mood, emotion, and feeling. Recent theoretical development in psychology, especially the work by Russell (2003), has made great progress in defining a number of important affective concepts. Here we introduce the ones necessary for our theoretical reasoning and empirical investigation.

Core affect is a neurophysiological state that is consciously accessible as a simple, non-reflective feeling (James A. Russell 2003). *Affective quality* is a stimulus’ ability to cause a change in core affect (James A. Russell 2003). Whereas core affect exists within the person, affective quality exists in the stimulus. Objects, artifacts, places, and events all have affective quality. They enter consciousness being affectively interpreted. *Perception of affective quality* (PAQ) is an individual’s perception of an object’s ability to change his or her core affect. It is a perceptual process that estimates the affective quality of the object. It begins with a specific stimulus and remains tied to that stimulus (James A. Russell 2003). Perception of affective quality has been called other terms such as evaluation, automatic evaluation, affective judgment, affective reaction, and primitive emotion, and it is considered a ubiquitous and elemental process (Cacioppo et al. 1999; James A. Russell 2003; Zajonc 1980).

From the perspective of studying human interact with ICT, we are interested in the connection between a person's affect and the possible affect-eliciting quality of an ICT. Perception of affective quality is a construct that makes such a connection (Zhang et al. 2004). *Emotions* are induced affective states (James A. Russell 2003). They typically arise as reactions to important situational events (Reeve 2005) and objects in one's environment. Once activated, they generate feelings, arouse the body into action, generate motivational state, and express themselves publicly.

In the ICT context, various affect related concepts have been studied, such as cognitive absorption (Agarwal et al. 2000), flow (Csikszentmihalyi 1988, 1990; Finneran et al. 2003, 2005; Ghani et al. 1994), and computer playfulness (Webster et al. 1992), perceived affective quality (Zhang et al. 2004, 2005), and even attitude that was sometimes treated as affect. Sun and Zhang have provided a comprehensive survey of the IS literature on affect in IS where they depicted some discrepancies in conceptualization and operationalization of affective concepts in the literature (Sun et al. 2006).

4. The Relationship between Aesthetics and Affect

4.1 The Implied and Ambiguous Relationships

There seems to be various implied relationships between aesthetics and affect that scholars have established in studies on either aesthetics or emotional design. For example, Lindgaard and Whitefield were surprised that so many recent publications centering specifically on emotion in design unaccountably neglect aesthetics (Lindgaard et al. 2004), yet they did not explicitly state what the exact relationship between aesthetics and affect/emotion should be. Tractinsky argued that aesthetics satisfies basic human needs when ICT users strive for a more complete and satisfying interactive experience that not only achieves certain well-defined goals but also involves the senses and generates affective responses (Ben-Bassat et al. 2006; Tractinsky 2006). Here it is implied that the aesthetic aspect of ICT has something to do with affective responses. In a workshop call (Ciolfi et al. 2005), the concept of aesthetic experience is implied to be a broader one including emotional design (Norman 2004) and funology (Blythe et al. 2005; Hassenzahl et al. 2001; Monk et al. 2002).

One exceptional work is Norman's three-level processing for emotional design where the connection between aesthetics and emotion is made explicitly (Norman 2004). The visceral processing requires visceral design, which leads to appearance (and attractiveness); the behavioral processing requires behavioral design, which is about the pleasure and effectiveness of use (and usability and performance); and finally, the reflective processing requires reflective design that is about self-image, personal satisfaction, and memories (and beauty).

Another work that is worth mentioning is by Tractinsky and colleagues. As mentioned earlier, Lavie and Tractinsky developed a two-dimensional structure for perceived aesthetics: classical and expressive aesthetics (Lavie et al. 2004). Their investigation (four empirical studies) was not guided by any affective approach or affective theories but was based on what users considered as aesthetics in Web sites, which focuses on the appearance of websites (thus a bottom-up approach). Later, Tractinsky and Lowengart associated the two aesthetics dimensions to the Mehrabian and Russell's two main dimensions of affective quality of environment: the classical

aesthetics is associated with the pleasure dimension and the expressive aesthetics is associated with the arousal dimension (Tractinsky et al. 2007). Such an association may have some empirical support because an examination of the items in their instrument development processes indicates that there are many items that are affective in nature. Yet, the association happened after the instrument was developed, and it needs better theoretical justification. The finalized instrument needs to be examined again on whether and to what extent it conveys the affective nature of aesthetics. For example, the affective structure indicates that both the pleasant and the arousal dimensions have negative values. Yet, all negative items during the aesthetics instrument development were removed. After all, the aesthetics instrument was not developed from an affective perspective (Lavie et al. 2004).

The third work worth mentioning is by Kim and Moon who examined “emotions” as immediate affective feelings about cyber-banking system interfaces (Kim et al. 1998). The emotion space is defined by seven dimensions including attractiveness, symmetry, sophistication, trustworthiness, awkwardness, elegance, and simplicity. These dimensions are non-basic (vs. basic emotions such as joy, anger, etc.) and domain-specific. Here it is hard to tell if all seven dimensions are more aesthetics related or affect related.

4.2 The Proposed Theoretical Relationship

The following scenario may help illustrate some considerations of examining aesthetics from an affective perspective:

You are browsing the Internet. Then, an unexpected advertisement window along with an audio message pops up your screen. Your attention is involuntarily switched to the advertisement and you notice that the ad appears to be beautiful and pleasing to the eye, and the audio tone itself is musical and pleasing to the ear.

What you feel now cannot be just described by the pleasantness/unpleasantness. It also includes the mind’s alert level being high, that is, the activation level is high. The pleasantness and activation aspects fit the circumplex model of affect, and overall you have an affective reaction toward this ad. In Watson and Tellegen’s word, you are experiencing a positive affect (Watson et al. 1988). Your perceived aesthetic quality of the ad would be positive.

Now, imagine a slightly different situation:

You are visiting a website in an urgent need of a piece of information. Then suddenly, an unexpected advertisement window pops up on your screen with an audio message (the same ad as in the previous scenario). Despite that the appearance of the ad is beautiful and pleasing to the eye, and the audio tone is musical, the sudden sound is very irritating, and it is annoying to you that your attention is involuntarily shifted to this ad and you have to either hear the whole audio message out or find ways to shut it down.

In this second scenario, the aesthetic quality of the ad (the objective aspect of the aesthetics) should be the same since it is the same ad, but the ad has a different effect on your affect now: your mind’s alert level is still high and you feel irritated and annoyed, which are negative affect. Such negative affect reflects your reaction to the ad: the ad is irritating and annoying. This

reflection directly relates to your perceived aesthetic quality of the ad, which would be more negative than positive. In addition to the negativity, this scenario also demonstrates the subjectivity and interaction aspects of aesthetics: your appropriation of the ad's aesthetic quality is based on your own social, cultural, historical standard that is made within the particular use situation. One would agree that given the situation, this ad is of bad taste, not suitable and not appreciated for the sense (the ear) as well as the mind.

Since the perception of an object's aesthetic quality is much connected to the viewer's affective reaction to the object, it is only natural that aesthetic quality and its perception are investigated with an anchor to affect and affect's structure. This is not to say that aesthetics and affect are the same concept. In our view, a simple way to differentiate and connect aesthetics and affect is to say that aesthetics emphasizes the quality of an object or stimulus and the perception of such quality in one's environment, and affect emphasizes the innate feelings people have that are induced by the object (such as emotions and affective evaluations). Aesthetics studies focus on objects or stimuli and their impact (that is, affective impact) on people; while affect studies focus on people's affective reactions toward stimuli. In this view, aesthetics can be regarded as means to achieve people's desirable affective states. That is, the purpose of designing an artifact with high positive aesthetic quality is to induce high positive affect in the viewers/users; and the purpose of designing the artifact with high negative aesthetic quality is to lead viewers to have high negative affect.

This anchoring of aesthetics to affect has another benefit. Affect is relatively better conceptualized than aesthetics. Thus we can borrow the key conceptualizations and structures in the affect camp to assist investigations on aesthetics. Specifically, affect structure shows two dimensions: pleasure and arousal. The pleasure dimension is readily correspondent to pleasing quality or pleasure effect of aesthetics and beauty. The arousal dimension is often missing. Or, if we take the two dimensions of positive affect and negative affect, the positive affect dimension is roughly covered by existing aesthetics studies, but the negative one is mostly missing.

5. Conclusion

Studies on aesthetics and affect in ICT context are timely and important. Yet, with regards to confusions and inconsistencies on the basic concepts, few studies provide clear theoretical foundations. This study anchors aesthetics to a fundamental human aspect, affect, and treats aesthetics as means to reaching a higher goal of desirable affective states. This leads to a theoretically driven approach to investigate various aesthetic concepts and the corresponding affective concepts. Using a theoretical approach to study aesthetics is highly promising to prevent ad hoc and inconsistent efforts and findings. In this paper, we examined the nature of aesthetics and beauty, then tied them to the purposes or effects, to positively influence users' affective feelings. This theoretical linkage is significant because it directs a different way of studying aesthetics based on a rich theoretical foundation of affect studies. This linkage also unites seemingly different efforts on aesthetics and emotional design in ICT context together into one coherent effort thus advances the field at a higher level.

We call for further research efforts to extend the findings in this study and to enrich our general understanding of the phenomenon of aesthetics and affect in human ICT interaction. There are several potential directions for future research. For example, additional theoretical investigation

is needed to provide even more detailed guidance on research and practice. The measurements for both affective constructs and aesthetic constructs need to be developed with a clear theoretical understanding. The measurements should be validated in various ICT contexts. Formal investigations are needed on the effects of aesthetic and affective related constructs on other human ICT interaction factors such as cognitive beliefs, attitudes, use and performance in various ICT use situations. Fortunately, some of these investigations are on the way by scholars in IS and HCI fields.

References

- Agarwal, R., and Karahanna, E. "Time Flies when You're having Fun: Cognitive Absorption and Beliefs about Information Technology Usage," *MIS Quarterly* (24:4) 2000, pp 665-694.
- Barrett, L.F., and Russell, J.A. "The structure of current affect: Controversies and emerging consensus," *Current Directions in Psychological Science* (8:1) 1999, pp 10-14.
- Ben-Bassat, T., Meyer, J., and Tractinsky, N. "Economic and Subjective Measures of the Perceived Value of Aesthetics and Usability," *ACM Transactions on Computer-Human Interaction* (13:2) 2006, pp 210 - 234.
- Blythe, M.A., Overbeeke, K., Monk, A.F., and Wright, P.C. (eds.) *Funology: From Usability To Enjoyment*. Kluwer Academic, Norwell, MA, 2005.
- Cacioppo, J.T., Gardner, W.L., and Berntson, G.G. "The affect system has parallel and integrative processing components: Form follows function," *Journal of Personality and Social Psychology* (76) 1999, pp 839-855.
- Ciolfi, L., Cooke, M., Bertelsen, O.W., and Bannon, L.J. "Understanding & Designing for Aesthetic Experience," The 19th British HCI Group Annual Conference, Edinburgh, UK, 2005.
- Csikszentmihalyi, M. "The flow experience and human psychology," in: *Optimal Experience: Psychological studies of flow in consciousness*, M. Csikszentmihalyi and I.S. Csikszentmihalyi (eds.), Cambridge University Press, New York, 1988, pp. 15-35.
- Csikszentmihalyi, M. *Flow: the psychology of optimal experience* Harpers Perennial, New York, 1990.
- Dewey, J. *Art as Experience* Southern Illinois University Press, Carbondale, IL, 1987.
- Fernandes, G., Lindgaard, G., Dillon, R., and Wood, J. "Judging the appeal of web sites," The 4th World Congress on the Management of Electronic Commerce, McMaster University, Hamilton, ON, 2003.
- Finneran, C.M., and Zhang, P. "A person-artefact-task (PAT) model of flow antecedents in computer-mediated environments," *International Journal of Human-Computer Studies* (59:4), 10 2003, pp 475-496.
- Finneran, C.M., and Zhang, P. "Flow in Computer-Mediated Environments: Promises and Challenges," *Communication of the AIS* (15) 2005, pp 82-101.
- Fishwick, P.A. (ed.) *Aesthetic Computing*. The MIT Press, Cambridge, MA, 2006.
- Ghani, J.A., and Deshpande, S.P. "Task characteristics and the experience of optimal flow in human-computer interaction," *The Journal of Psychology* (128:4), July 1994, pp 381-391.
- Hartmann, J., Sutcliffe, A., and Angeli, A.D. "Investigating Attractiveness in Web User Interfaces," Conference on Human Factors in Computing Systems (CHI), San Jose, California, 2007, pp. 387-396.

- Hassenzahl, M., Beu, A., and Burmester, M. "Engineering Joy," *IEEE Software* (18:1), January/February 2001, pp 70-76.
- Izard, C.E. "Four Systems for Emotion Activation: Cognitive and Noncognitive Processes," *Psychological Review* (100:1), 1 1993, pp 68-90.
- Kim, J., and Moon, J.Y. "Designing towards emotional usability in customer interfaces-- trustworthiness of cyber-banking system interfaces," *Interacting with Computers* (10:1), 3 1998, pp 1-29.
- Lavie, T., and Tractinsky, N. "Assessing dimensions of perceived visual aesthetics of web sites," *International Journal of Human-Computer Studies* (60:3), March 2004, pp 269-298.
- Lindgaard, G., Fernandes, G.J., Dudek, C., and Brown, J. "Attention web designers: You have 50 milliseconds to make a good first impression!," *Behaviour & Information Technology* (25:2) 2006, pp 115-126.
- Lindgaard, G., and Whitfield, T.W.A. "Integrating aesthetics within an evolutionary and psychological framework," *Theoretical Issues in Ergonomics Science* (5:1), January-February 2004, pp 73-90.
- Monk, A., Hassenzahl, M., Blythe, M., and Reed, D. "Funology: designing enjoyment," Conference on Human Factors in Computer Systems (CHI), 2002, pp. 924-925.
- Mundorf, M., Westin, S., and Dholaski, N. "Effects of Hedonic Components and User's Gender on the Acceptance of Screen-Based Information Services," *Behaviour & Information Technology* (12:5) 1993, pp 293-303.
- Norman, D.A. "Emotion and design: Attractive things work better," *Interactions: New Visions of Human-Computer Interaction* (IX:4), July + August 2002, pp 36-42.
- Norman, D.A. *Emotional Design: Why We Love (Or Hate) Everyday Things* Basic Books, Cambridge, MA, 2004.
- Reeve, J. *Understanding Motivation and Emotion*, (4th ed.) John Wiley & Sons, Inc., New York, 2005.
- Russell, J.A. "A circumplex model of affect," *Journal of Personality and Social Psychology* (39) 1980, pp 1161-1178.
- Russell, J.A. "Core Affect and the Psychological Construction of Emotion," *Psychological Review* (110:1), 1 2003, pp 145-172.
- Schenkman, B.N., and Jonsson, F.U. "Aesthetics and preferences of web pages," *Behaviour & Information Technology* (19:5), September 2000, pp 367-377.
- Shusterman, R. *Pragmatist Aesthetics. Living Beauty, Rethinking Art* Blackwell, 1992.
- Sun, H., and Zhang, P. "The Role of Affect in IS Research: A Critical Survey and a Research Model," in: *Human-Computer Interaction and Management Information Systems: Foundations*, P. Zhang and D. Galletta (eds.), M.E. Sharpe, Armonk, NY, 2006, pp. 295-329.
- Tractinsky, N. "Aesthetics in Information Technology: Motivation and Future Research Directions," in: *Human-Computer Interaction and Management Information Systems: Foundations*, P. Zhang and D. Galletta (eds.), M.E. Sharpe, Armonk, NY, 2006, pp. 330-347.
- Tractinsky, N., Cokhavi, A., and Kirschenbaum, M. "Using ratings and response latencies to evaluate the consistency of immediate aesthetic perceptions of web pages," Third Annual Workshop on HCI Research in MIS, Washington, Washington, D.C., 2004, pp. 40-44.

- Tractinsky, N., Cokhavi, A., Kirschenbaum, M., and Sharfi, T. "Evaluating the Consistency of Immediate Aesthetic Perceptions of Web Pages," *International Journal of Human Computer Studies* (64:11) 2006, pp 1071-1083.
- Tractinsky, N., Katz, A.S., and Ikar, D. "What is beautiful is usable," *Interacting with Computers* (13) 2000, pp 127-145.
- Tractinsky, N., and Lowengart, O. "Web-based aesthetics in E-retailing: A conceptual framework and some theoretical implications," *Academy of Marketing Science Review* (11:1) 2007, pp 1-18.
- Udsen, L.E., and Jorgensen, A.H. "The aesthetic turn: unravelling recent aesthetic approaches to human-computer interaction " *Digital Creativity* (16:4) 2005.
- van der Heijden, H. "Factors Influencing the Usage of Websites - The Case of a Generic Portal in the Netherlands," *Information & Management* (40:6) 2003, pp 541-549.
- Wasserman, V., Rafaeli, A., and Kluger, A.N. "Aesthetic symbols as emotional cues," in: *Emotion in Organizations*, S. Fineman (ed.), SAGE, London, 2000, pp. 140-165.
- Watson, D., Clark, L.A., and Tellegen, A. "Development and validation of brief measures of positive and negative affect: The PANAS scales," *Journal of Personality and Social Psychology* (54:4) 1988, pp 1063-1070.
- Webster, J., and Martocchio, J.J. "Microcomputer playfulness: development of a measure with workplace implications," *MIS Quarterly* (16:1) 1992, pp 201-226.
- Yik, M.S.M., and Russell, J.A. "Predicting the big two of affect from the big five of personality," *Journal of Research in Personality* (35) 2001, pp 247-277.
- Zajonc, R.B. "Feeling and Thinking: Preferences Need no Inferences," *American Psychologist* (35:2), February 1980, pp 151-175.
- Zhang, P., and Li, N. "Love at First Sight or Sustained Effect? The Role of Perceived Affective Quality on Users' Cognitive Reactions to Information Technology," International Conference on Information Systems (ICIS'04), Washington, D.C., 2004, pp. 283-296.
- Zhang, P., and Li, N. "The importance of affective quality," *Communications of the ACM* (48 9), September 2005, pp 105-10.