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By examining the diagrams of technology users, we can gain insight into their perceptions. In this study, we collected diagrams from 41 participants. We found that these participants make use of both shape and position to differentiate themselves from the technology they use. Shape and position also differentiate hardware devices from software applications. Most users also draw direct connections between themselves and their applications, bypassing in their diagrams the devices that mediate this communication. Thus, devices may recede from awareness as we focus on applications and the information they make available.

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By examining the diagrams of technology users, we can gain insight into their perceptions. In this study, we collected diagrams from 41 participants. We found that these participants make use of both shape and position to differentiate themselves from the technology they use. Shape and position also differentiate hardware devices from software applications. Most users also draw direct connections between themselves and their applications, bypassing in their diagrams the devices that mediate this communication. Thus, devices may recede from awareness as we focus on applications and the information they make available.

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Introduction

Do we interact with our devices? Or do we interact with information? Well-designed devices may become so transparent, that we stop noticing them (Norman 1999); they may become absorbed into our sense of self (Clark 2003; Licoppea et al. 2005). These predictions are important to test, because understanding the way we perceive technologies is an important step in designing better ones (cf. Dwyer 2007; Kiesler et al. 1984).

Diagrams and sketches may provide such insights into cognition because they externalize the thoughts of the sketchers (Blackwell 1997; Bresciani et al. 2008; Tversky 2002). Many aspects of sketching, such as starting positions and angles, are phenomena that can be studied through observation and experiment, and these phenomena exhibit remarkable stability (van Sommers 1984). In our previous studies we found that the diagrams of systems designers reveal much about how they perceive technology (Nickerson et al. 2008a; 2008b). These diagrams reflect the ways we categorize the world, making use of the affordances of the page, the possibilities for expression offered through sketching. For example, we found that designers almost always positioned a search engine high in a diagram, and a store low (Nickerson et al. 2008a). A cell phone was drawn close to the user, and a satellite further away. This positioning reveals the designer's perception of technology, and the results were consistent across individuals with widely varying levels of technology experience. This leads us to ask whether diagrams can also be used to gain insight into the way *users* think about technology.

In the information systems field, user perceptions have often been studied with textual surveys about usefulness and ease of use (e. g. Davis 1989). Here, in contrast, we ask users to *diagram* the relationship between themselves and the technologies they use. These diagrams will function much as a concept map does, as a way of eliciting understanding (cf. Novak 1990). Moreover, we will focus on the ways people find to express their relationships to technology. People continuously discover and rediscover visual conventions for communicating concepts, an old idea (cf. Peirce 1931) that has recently been reinforced through research in experimental semiotics showing how new specialized languages are created out of diagrammatic and gestural communication (Galantucci 2009; Steels 2002; Voiklis 2008).

Insights gained in this research may of interest to several communities. For the designer of drawing and visualization packages for social software, it is important to know how people naturally represent their world (cf. Visser 2006). In particular, we will show how people use affordances of the page, such as distance and angle, to communicate and conceptualize abstract ideas, such as the strength of relationships (cf. Granovetter 1973). For those involved in the understanding of diagrams, and, more specifically, the pedagogy of information systems, understanding the range of diagrams produced will be of interest. For those interested in the representation of information systems, this work is one of a series of papers that we have written exploring the way measures of similarity in representations – such as distances between objects in a diagram – can be used to understand technology usage and design (Nickerson et al. 2008a; 2008b).

Predictions

In our previous work, we have found that the constraints of the visual medium influence the representations used (Nickerson et al. 2008a). Based on this work, we predict that the affordances of the page will be used to express the users' perception of technologies. The affordances are the possibilities for action inherent in the page, and include properties such as *position*. Thus, by looking at participants' sketches, we may gain insight into the way users think about technology.

From this theory, we form several testable hypotheses concerning the way diagrams are likely to be expressed. Specifically, we expect to find that the user, a person, will be drawn differently than the technology, a thing. That is, if the person is a circle, the thing will be a square, in order to differentiate the two. By providing the users with an online drawing tool, we can restrict the repertoire of shapes, and thus we can test whether the shape choice corresponds to the type of object. With respect to position, we expect that people will put themselves at the center of diagram. We will also look at the positioning of the technologies: we expect that different types of objects will be drawn in different locations, as they were in our previous study (Yu et al. 2010), particularly with respect to horizontal and vertical location along the axes of the drawing (cf. Hayward and Tarr 1995).

We expect that computer hardware, *a device*, will be represented differently than computer software, *an application*. This expectation is consistent with a current idea: our interactions should no longer be conceptualized as being ones between ourselves and computers, but rather between ourselves and information (cf. Fidel et al. 2004; Scholtz 2006). In this way, the mediating computer disappears from our awareness, as we find ourselves accessing information from a variety of hardware devices. We can test this idea in the following way.

We expect that the users' representations of connectivity will not match the real connective topology of a computer network. Logically, we should expect to find the self connected to a computer that in turn is connected to an application such as email. But we expect that this logical prediction will be violated. That is, we expect that applications will be drawn directly connected to the user, rather than connected through a mediating computer device.

Experimental Method

To get the users' perceptions of their frequently used technologies, we designed an experiment to ask the participants to show their relationships with their communication technologies. Unlike traditional textual surveys in information system, we asked participant to draw diagrams. We expected those diagrams would reflect users' perceptions and prove our previous predictions.

In order to collect diagrams, a simple online drawing applet was developed so that study participants could create personal sketches in response to a question. This applet provided menu choices for the drawing of lines, circles, and rectangles, as well as the ability to label the components of the diagram. We found 41 subjects through a crowdsourcing marketplace, compensating them with nominal payments for participation. We collected demographic information after they completed the sketches: the participants ranged in age from 20 to 54, and slightly over half the participants were female.

The problem in the experiment was presented as follows:

Different communication technologies may play different roles in your life. Please draw a picture or a map that shows the relationship between you and the following communication technologies if you have them (home phone, office phone, cell phone, PDA, Facebook, Blogging, QQ, Twitter, E-mail, MSN, Skype, BBS, computer, etc.).

Results

Even though they were provided with only a simple drawing tool, participants produced widely varying configurations for this task, as can be seen in Figures 1 through 4.

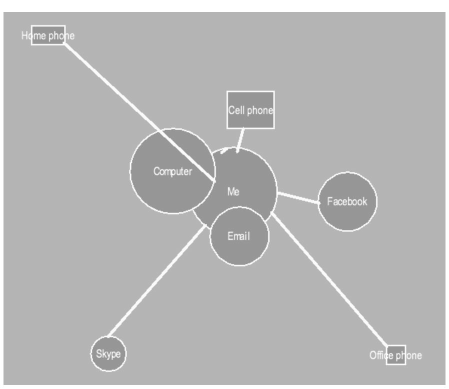

Figure 1. Participant 36.

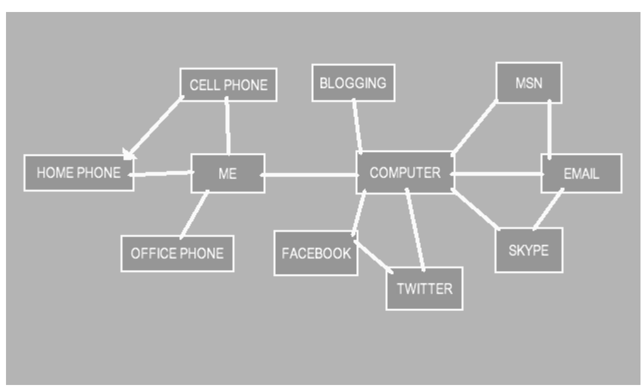

Figure 2. Participant 38.

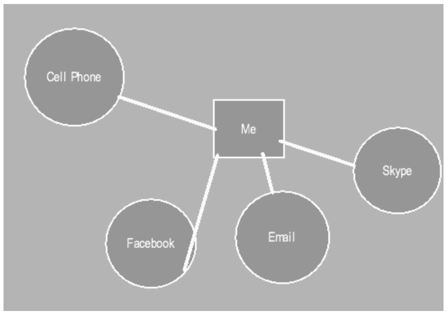

Figure 3. Participant 21.

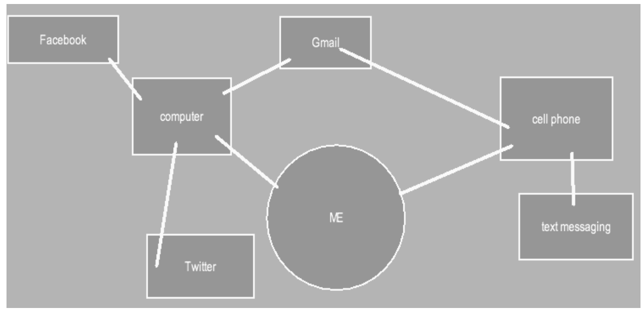

Figure 4. Participant 32.

In order to test whether or not *shape* was used to indicate *category*, we split the graphs into two main subsets: those in which shape was not used to differentiate between self and technology, as in Figures 1 and 2, and those in which the self was a different shape from all other nodes, as in Figures 3 and 4. A third subset consisted of five graphs that did not portray the self at all. Most participants (26) represented themselves with a different shape from that of the technologies. Only ten did not differentiate themselves by shape. This ratio is significantly greater than chance, as shown by a sign test ($z = 3.5$, $p < .01$).

We next examined the location of the self. Figure 5 plots the result: the self usually appeared in the center, as predicted. The self also appeared in two other clusters, drawn at the very top or bottom of the users' diagrams.

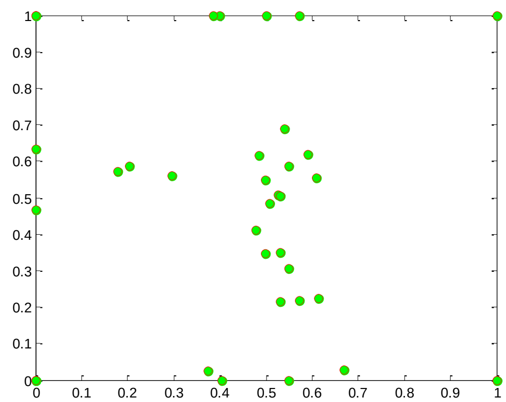

Figure 5. Users' positions in the graphs.

Roughly half of the participants drew themselves in the center. The rest of the participants were evenly split, with about one quarter of participants drawing themselves at the top, and one quarter at the bottom. Figure 6 shows caricatures – that is, prototypical diagrams for each of these categories.

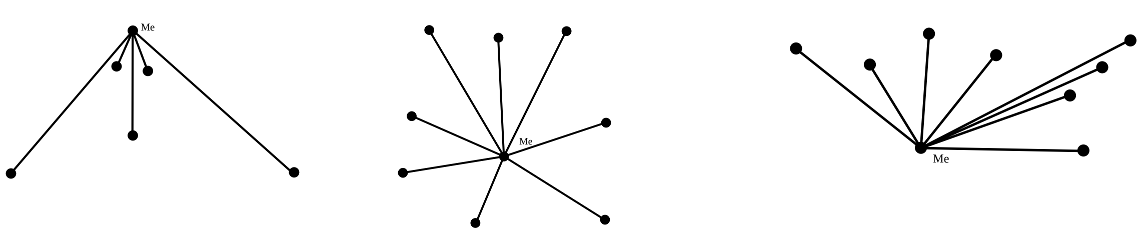

Figure 6. Ways the self is drawn in relation to the technologies.

Figures 7 and 8 show the locations of computers and cell phones, with the diagrams re-centered on the self. Table 1 provides a textual view of the results. From these displays we see that the most common devices, computers and cell phones, are usually positioned above the self, Facebook and Twitter are usually positioned below the self, and email ranges both above and below. Figure 9 shows these relationships graphically. Thus, computers and cell phones are positioned differently than applications.

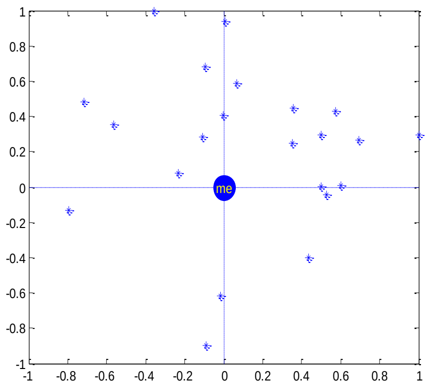

Figure 7. Computers' positions in the graphs.

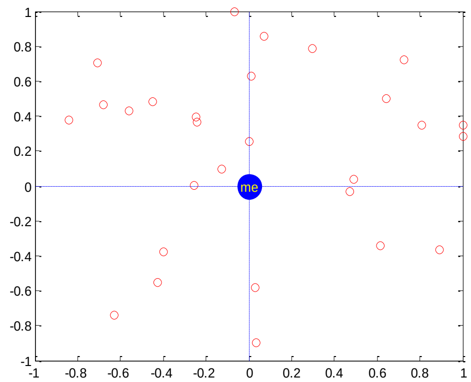

Figure 8. Cell phones' positions in the graphs.

Table 1. Frequency of the positions of the five most commonly depicted technologies in the graphs, classified as above or below the self.

	Position	
	Above	***Below***
Computer	18**	5**
Cell phone	22*	9*
E-mail	13	9
Facebook	5	11
Twitter	3	8

*$p < .05$; **$p < .01$

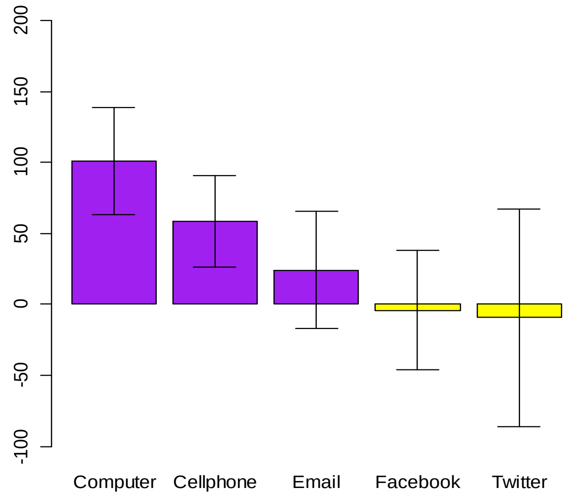

Figure 9. Means and standard errors of y-coordinates of five communication technologies.

We next analyzed connectivity. We split the diagrams into two main categories: those in which the self connects to applications only through hardware devices, and those in which the self connects to applications directly. In other words, we separated the diagrams into those that showed mediated versus direct communication. Some diagrams fell into two other categories: diagrams with no self (5), and diagrams with no applications (10). Figure 10 shows the number of mediated and direct diagrams. We can see that, as expected, most participants drew direct connections to application technology. In fact, ten participants completely omitted computers from their diagrams, even though they included applications.

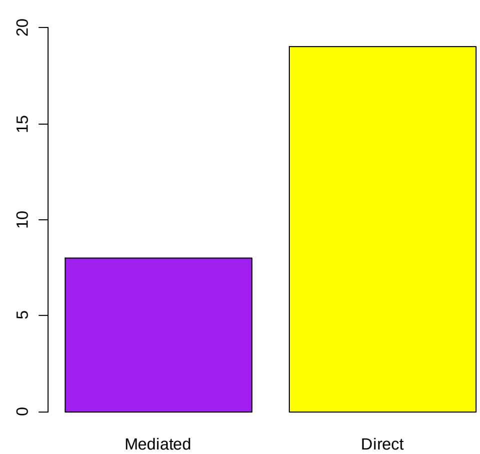

Figure 10. Number of mediated vs. direct diagrams.

Discussion and Conclusion

We asked participants to sketch their relationship to several common technologies, including both hardware devices and software applications. As we expected, shape and location were used to distinguish self from technology. The location of self, interestingly, was not always central, but sometimes on the extreme top or bottom. This positioning may reflect either alternative ways of showing hierarchy or alternate ways of using technology. For example, some users may feel themselves in control of technology, above it, while others may feel embedded in the technology, surrounded on all sides. Future research might look for differences in technology usage across groups portioned according to their portrayal of the technology they use.

Computers and cell phones were usually represented above the self, but applications tended to be located at or below the self. This may reflect the perceived primacy of the technologies, and this phenomenon might be studied by manipulating the set of technologies to be drawn. That is, older or more established technologies might usually be drawn first, and this could tested by pairing various new with various old technologies, with new technologies sometimes presented first, and sometimes second.

Topologically, ten people left computers out of their diagrams entirely, and most participants showed direct connections between themselves and their applications. This suggests that, at least for some, the devices have become transparent, an argument that has been made by both Norman and Clark. Future work might expand this study to more subjects and more technologies in order to further investigate what leads devices to be dropped from the diagrams. Perhaps the devices have really become invisible, or perhaps alternate devices are so interchangeable that applications are the most salient and stable technological components, the invariants.

For the designers of visualization tools, this work suggests that applications are often perceived independently of device, and should be drawn connected directly to the user. This new convention might be best for purely conceptual portrayals of the technical environment. If more accurate portrayals are needed, the mediating devices might be shown in the background, as elements of the infrastructure, or as overlays, to be inspected only in the event of breakdowns. We perceive applications as tools, and assume that they are running on whatever technology is ready at hand. That is, we are ultimately pragmatic about our technology, forming representations not for accuracy's sake, but instead to facilitate our constant tool-assisted interpretation of the world around.

Acknowledgments

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References

Blackwell, A. F. Diagrams about Thoughts about Thoughts about Diagrams, AAAI Technical Report FS-97-03, 1997.

Bresciani, S., Blackwell, A. F. and Eppler, M. J. A Collaborative Dimensions Framework: Understanding the Mediating Role of Conceptual Visualizations in Collaborative Knowledge Work, *HICSS*, 2008.

Clark, A. *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence*, New York: Oxford University Press, 2003.

Dwyer, C. Digital Relationships in the “MySpace” Generation: Results from a Qualitative Study, *HICSS*, 2007.

Davis, F. D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13, 3, 1989, 319-340.

Fidel, R., Pejtersen, A.M., Cleal, B. and Bruce, H. A multi-dimensional approach to the study of human-information interaction: a case study of collaborative information retrieval. *Journal of the American Society for Information Science and Technology*, 55, 11, 2004, 939-953.

Galantucci, B. Experimental semiotics: A new approach for studying communication as a form of joint action. Topics in Cognitive Science, 1(2):393-410, 2009.

Granovetter, M. "The Strength of Weak Ties", American Journal of Sociology, Vol. 78, Issue 6, May 1973, pp. 1360-1380

Hayward, W.G. and Tarr, M.J. Spatial language and spatial representation. *Cognition*, 55, 1995, 39-84.

Kiesler, S., Siegel, J., and McGuire, T. W. Social Psychological Aspects of Computer-Mediated Communication, *American Psychologist*, 39, 10, 1984, 1123-1134.

Licoppea, C. and Smoreda, Z. Are social networks technologically embedded?: How networks are changing today with changes in communication technology, *Social Networks*, 27, 4, 2005, 317-335.

Norman, D. *The Invisible Computer*, Cambridge, Mass: MIT Press, 1999.

Nickerson, J. V., Corter, J. E., Tversky, B., Zahner, D., and Rho,Y. The Spatial Nature of Thought: Understanding information systems design through diagrams, in Boland, R., Limayem, M., Pentland B.,(eds), Proceedings of the International Conference on Information Systems, 2008.

Nickerson, J.V., Corter, J.E., Tversky, B., Zahner, D., and Rho, Y.J. Diagrams as tools in the design of information systems. In J.S. Gero & A. Goel (Eds.), Design Computing and Cognition '08. Dordrecht, Netherlands: Springer-Verlag, 2008.

Novak, J. Concept maps and Vee diagrams: Two metacognitive tools to facilitate meaningful learning, *Instructional Science*, 19, 1990, 29-52.

Peirce, C. S., *Collected Papers*, Cambridge: Belknap Press of Harvard University Press, 1931.

Scholtz, J. Metrics for evaluating human information interaction systems. *Interacting with Computers*, 18, 2006, 507–527.

van Sommers, P., Drawing and Cognition: Descriptive and Experimental Studies of Graphic Production Processes, Cambridge University Press, 1984.

Steels, L. (2002). Iterated learning versus language games: Two models for cultural language evolution. *Intl. Workshop of Self-Organization and Evolution of Social Behaviour*.

Tversky, B. What do sketches say about thinking? In T. Stahovic, J. Landay, and R. Davis (Editors), Proceedings of AAAI spring symposium on sketch understanding, 2002.

Visser, W. “Designing as Construction of Representations: A Dynamic Viewpoint in Cognitive Design Research”, *Human-Computer Interaction*, *Special Issue "Foundations of Design in HCI"*, (21:1), 2006, pp. 103-152.

Voiklis, J. A Thing Is What We Say It Is: Referential Communication and Indirect Category Learning. PhD thesis, Columbia University, New York, 2008.

Yu, L., Nickerson, J.V. and Tversky, B., Discovering Perceptions of Personal Social Networks through Diagrams,*Seventh International Conference*, *Diagrams 2010, Proceedings. Springer*, *LNAI 5223, 2010*

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