

A Study on Smart Phone Icons: Styles and Recognition

Guo, Qing^a; Kang, Sunghyun^{b*}

^a Eargo, San Jose, California, USA

^b Graphic Design, Iowa State University, Ames, Iowa, USA

* shrkang@iastate.edu

Current smartphone manufacturers share similar icon styles, which is a materialized drawing with filtered details. A well-designed and well-formatted icon can make the interaction quicker and easier. However, complex information can become confusing and may appear muddy at smaller sizes. With regards to different simplicity levels and styles, this study examines at what point viewers have trouble recognizing smartphone icons. Twenty-five icons focusing on five primary functions of the smartphone were generated for this study. This experiment was divided into two phases: 1) a study to identify the most recognizable icons, and 2) a study to test recognizability with simplified icons that were designed based on the findings from the phase 1 study. Data was collected from a total of 1,305 online survey participants. This study found that simplified icons with minimal elements did not decrease their recognizability when the form included visual cues for meaning recognition. When the visual cues did not represent the meaning, viewers misinterpreted the meaning of the icons

Keywords: *Icon Recognition, Visual Cue, Icon Style, Smartphone*

1 Introduction

Icons are not a product of modern society, instead, they are one of the oldest communication forms that can be traced back to ancient ages. Before having languages to communicate, ancient people began to express themselves through facial expressions, postures, and gestures (Horton, 1994). As shown by cave paintings that were found by modern archaeologists, ancient people used simple pictorial images to represent objects from nature to record, mark, and communicate. For example, they drew abstract cows to record how many cows they owned or to mark ownership. In the modern written Chinese language, we can still see the original objects in some characters. Also, drawing on the ancestry of the icon is Semantography. Semantography, also known as Blissymbolics, as designed by Charles Bliss, is defined as an ideographic writing system including “several hundred basic symbols, each representing a concept, which can be composed together to generate new symbols that represent new and more complex concepts” (<http://www.blissymbolics.org/>).

Current icons represent modern society, globalization, or even a high technology world. Understanding an icon is based on viewer interpretation. Icons can be seen everywhere, no matter if they are offline or online, or physical or digital interfaces. Icons are commonly seen where visual information is needed to be provided in order for viewers to grasp the main content easily and quickly. Common examples of this are road signs, computer screens, and

machine control panels. Summing up information visually and graphically, icons provide relatively higher readability than text and even make text unnecessary in some situations (Mertz, 2012). This is especially true for those people who are illiterate in certain languages (Horton, 1994). Apart from higher readability compared to text; icons save space. What's more, the fewer details an icon carries, the less space is needed to display this icon clearly (Torralba, 2009). With complex icons, it is difficult to see and recognize small details when the icons are at a reduced size compared to a larger size. What's more, complex details can become confusing and may appear muddy at a smaller scale (iOS human interface design guidelines, 2015).

In the rapidly growing smartphone industry, some mobile phone brands gradually grew to occupy most of the market—Samsung, Apple and Lenovo share around half of the market worldwide. Even though these smart phones were produced by these three different manufacturers, the existing icons on their interfaces look similar in terms of design style and icon appearance. Every smartphone brand's icons seem alike. The current icon situation is that they share a similar style—a materialized drawing with filtered features. Apple tends to use flat, solid colored geometrics; Samsung and Lenovo are more likely have 3-dimensional elements in order to be relatively more realistic.

Seeing means grasping the essentials. By only one glance, people can tell the rectangularity of a building, the roundness of a ball, the curve of hair, et cetera. One of the most outstanding features of visual stimuli is their shapes. We can see two kinds of shapes: one is a physical shape and the other one is a conceptual shape (Arnheim, 1974). Physical shape is picked out by the physical boundary—edges, sides, and outline; perceptual shape comes from the interaction among objects—shadow, gestalt, etc. Decoding is technically a process of connecting the icon with existing knowledge of the physical boundary in order to determine what it is. When a viewer encounters an icon, he or she will try to determine the known concepts that are associated with this visual perception. If there are no matched pairs, this icon will be decomposed into simpler graphics for matching familiar simpler concepts until the viewer can determine the meaning of this icon by combining all of the separated subparts' meanings together. Therefore, we can regard decoding as assigning a verbal concept to a visual perception. When we look at an icon, what we see comes from our memories instead of only from our eyes (Horton, 1994). What we have already seen affects the way we see now and, in the future, because we tend to 'see' what we have already known.

According to the Oxford Dictionary, simplicity is defined as "the quality of being easy to understand or do." But simple never means minimal (Colborne, 2011). Simplicity in this paper is defined as the minimal elements that enable the icon to be recognized with the given meaning. If an icon is a simple shape, viewers can focus only on the most essential characters. Therefore, the process of getting information will be quick and direct.

This study had three goals: to investigate at what level of simplicity icons can maintain their ability as a visual cue; to seek whether different guidelines can be formed for designers to design more abstract and simplified but still recognizable icons; determine recognition in different icon styles. Two research questions were generated to seek the answers: at what point can viewers recognize icons on smartphone interfaces, regarding different levels of simplicity and design style; and how do viewers' recognition abilities vary due to demographic information such as age, gender, and educational background?

2 Research Methods and Procedures

Because we see the world in a common way, pictorially representing existing natural objects is a shortcut to showing an object shared by senders and receivers. One study run by Rungtai Lin (Lin, 1994) shows that the highly recognized icons always have strong ties with an existing object. “Skeuomorphism” as a design principle also indicates that: design cues should be taken from the physical world. The design aiming to recall the existing world makes visual elements more familiar to viewers (Cho, et al, 2015). Another study found that participants tended to associate physical objects with the meaning of the icon (Sengupta, et al, 2015 CHI). According to Horton (1994), icons can be classified into five levels of realism: photograph, drawing, caricature, outline, and silhouette. A photograph is the most detailed and realistic level while the silhouette is the most simplistic and abstracted. Twenty-five icons were developed based on Horton's classification with objects and graphical elements. Figure 1 shows each icon design with five different levels of simplification and styles designed for the Phase 1 study. Instead of photographic icons, form reduction icons were added to investigate the simplified form with visual cues base on Horton’s icon classification. Five most frequently used icons of the smartphone such as Phone Call, Message, Email, Camera, and Browser were selected to examine recognition. In the icon development process, icons from Apple, Samsung, and Lenovo were studied as a reference.

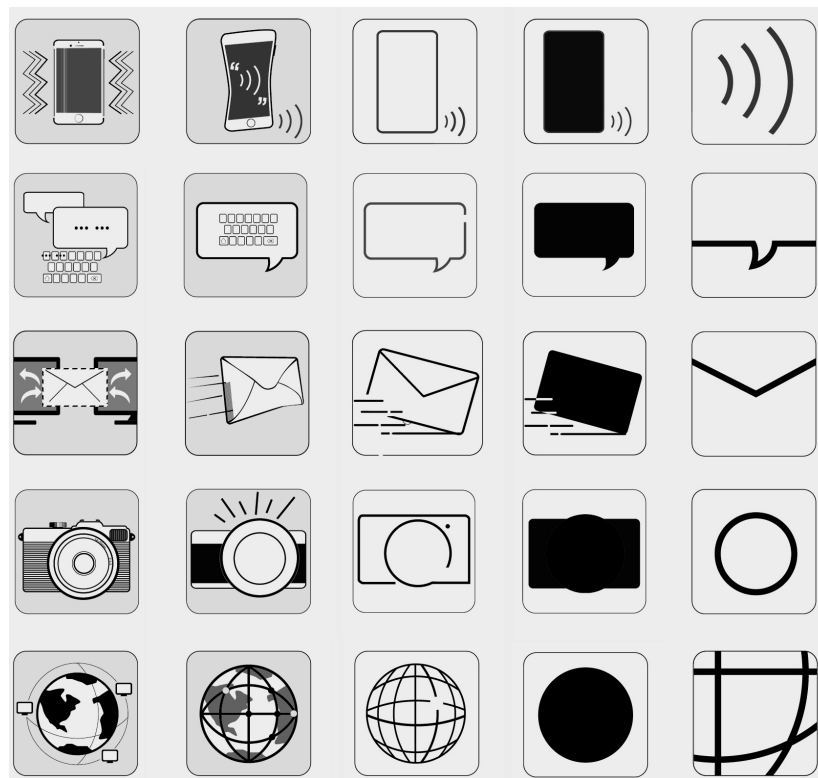


Figure 1. Twenty-five Icons with five different styles and simplicity levels for the Phase 1 study. In the row shows drawing, caricature, outline, silhouette, and form reduction style respectively and in the column shows a phone call, message, email, camera, browser respectively.

Apple’s iPhone Human Interface Guidelines claim that a target size of 44 x 44 pixels is the minimum. (<https://developer.apple.com>). The icons’ actual size appearing in the surveys was 88 x 88 pixels (twice as big as the standard icon size) because a study run by Ankrum, D.R. (1999) showed that the comfortable eye-to-computer distance is at least 25 inches, which is twice as far as the eye-to-phone distance (12 inches).

After receiving Institutional Review Board approval, the online surveys were conducted to better comprehend icon recognition at a large university in the USA. The study was divided into two phases and participants' information was collected from all surveys. In the Phase 1 survey, each of the icon's five styles were shown, and participants were asked to choose all of the icons they could recognize with the given meaning. For example, "Select icon(s) that indicate(s) 'Phone call'. Please check all that apply (Multiple Answer)." The purpose of this survey is to find out participants' recognition of given icons and meaning. From the results of the Phase 1 survey, two sets of the five most recognizable icons and the simplest recognizable icons were selected for Phase 2. After the Phase 1 study, form-reduction-style icons were created as shown in Figure 2 to increase the recognition for the second phase study.



Figure 2. Modified form-reduction-style icons for the Phase 2 study shown as a phone call, message, email, camera, browser respectively.

In the Phase 2 survey, each set of the five icons were presented to the separate participant groups. Each participant was asked to identify the function of the icon and to scale their confidence level in the six-level Likert scale from minus 3 to plus 3. The scale was labeled with "strongly not confident," "not confident," "somewhat not confident," "somewhat confident," "confident," and "strongly confident." Each participant took only one survey and there was no overlap with participants across the surveys. Also, the order of the simplicity level was randomly arranged in all of the studies. The purpose of this survey was to identify the participant's understanding of each icon's function and their confidence level in their choice.

The data was downloaded from Qualtrics into IBM Statistical Package for the Social Sciences (SPSS). All data were analyzed in SPSS. One-way analysis of variance (ANOVA) tests were conducted to examine significant effects. A significance level of $p \leq .05$ was used for all ANOVA analyses.

3 Results and Findings

3.1 Phase 1

In Phase 1, 528 students completed the survey. Among all participants, 510 of the participants' data were analyzed with valid answers. Group 1 was composed of 54.7% female and 45.3% male students. The age distribution of the participants ranged from 18 to 64 years old. About 75% of participants were from 18 to 24 years old, 22% were 25 to 34 years old, and 4% were older than 35 years old. Regarding backgrounds, 35.3% of participants were graduate students, 62% were undergraduate students, and 2.5% had high school or lower educational backgrounds. Of the 510 participants, 88.4 % were native speakers of English, and 11.6% were non-native English speakers. About 31% of participants used Samsung phones, 49% of participants used Apple phones, and 20% of participants used other phone brands.

Table 1 shows the results of the Phase 1 survey. In four out of the five questions in Phase 1, the outline-style icons were relatively more recognizable for participants than other icon styles. The recognition rate for the Message, Email, and Browser style icons was especially strong at over 80% for the outline-style. Even though the most recognizable style for the Camera icon was drawing, the recognition rate of the outline-style icon was still more than 50%. Therefore, it can be inferred that the outline-style icons were the most recognizable of the five icon styles. Even though the form-reduction-style icons were extremely simplified icons, they were still recognizable according to the results. The “Phone Call” icon was recognizable for 22% of participants, the “Message” icon’s recognition rate was 29%, the “Email” icon was recognizable for 37% of participants, and the recognition rates for the “Camera” and “Browser” icons were 13% and 8% respectively. Additionally, it is worth mentioning that silhouette-style icons likely had lower recognition rates than that of other style icons except the Phone Call and Message icons.

Table 1. Twenty-five Icons Recognition Study

	Drawing	Caricature	Outline	Silhouette	Form Reduction
Phone Call	46%	36%	53%	49%	22%
Message	50%	34%	86%	72%	29%
Email	32%	66%	88%	7%	37%
Camera	89%	69%	51%	9%	13%
Browser	60%	66%	80%	1%	8%

3.2 Phase 2

Because the purpose of the study is to find the breaking point of simplicity at which viewers begin to feel lost or lose the ability to recognize icons, five outline-style and form reduction style icons were selected for the Phase 2 study. As mentioned in the methods and procedures, form reduction style icons (Figure 2) were revised for better recognition. Each set of icons was used in an online survey.

For the outline style icon survey, a total of 415 students participated and 409 participants’ data were valid for analysis. Of the students participating, 56 percent were female and 44% were male and the age distribution of the subjects ranged from 18 to 54 years: Ninety-one percent of them were from 18 to 24 years old, 7 % of participants were from 25 to 34 years old, and the percentages of both 35 to 44 years old and 45 to 54 years old were one percent. Eighty-six percent of participants were undergraduate students, nine percent of them were graduate students, and five percent of participants had high school or lower educational backgrounds. Ninety-five percent of participants were native speakers of English and five percent were not native speakers. Twenty-eight percent of participants used Samsung phones, 57% of participants used Apple phones, and 15% of participants used other phone brands.

Table 2 shows the icon recognition rate and confidence level of the outline style icons. Among the outline style icons, the “Phone Call” icon recognition is the lowest with 15.4% correct answers. The mean value of participants’ confidence level was minus 0.1057, which means that participants tended to be “somewhat not confident” with their answers when they guessed the function of the “Phone Call” icon. Most participants recognized the “Phone Call” icon as speaker, voice, volume, and so on. The wave image beside the phone affected the recognition even though it is a small and secondary element. This result also shows that participants did not recognize the association of the smartphone shape with a phone call.

The “Browser” icon’s correct recognition rate was about 87%, and the mean value of participants’ confidence level was at around 1.5. This indicates that when participants guessed the meaning of the “Browser” icon, participants’ confidence level was between “somewhat confident” and “confident.” The recognition rate for three icons, “Message,” “Email,” and “Camera,” was higher than 90%, and participants’ confidence level mean values were all around 2, which stands for feeling “confident.” What’s more, the “Camera” icon enjoyed the highest correct recognition rate (98%), and the mean value of participants’ confidence level (2.1275) was between “confident” and “strongly confident.”

Table 2. Recognition of the Outline Style Icon and Confidence Level

	Phone Call	Message	Email	Camera	Browser
Recognition	15.4%	97.1%	91.2%	98%	86.8%
Confidence Level	-.1057	1.6201	1.8382	2.1275	1.4755

For the form reduction survey (Figure 2), 394 students participated in the study and 386 participants’ data were valid for the analysis. Participants were composed of 52.6% female and 47.4% male students. The age distribution of the participants ranged from 18 to 74 years old: 90.7% of participants were from 18 to 24 years old, 7.5% were 25 to 34 years old, and less than 2% were older than 35 years old. About 12% reported themselves as graduate students and 87% of participants reported themselves as undergraduate students. Of the 386 participants, 93% were native speakers of English and seven percent of participants were non-English native speakers. Also 26.4% participants used Samsung phones, 57.5% used Apple phones, and 16% used other phone brands.

Table 3 shows the icon recognition rate and confidence level of the form reduction style icons. The “Phone Call” icon in this study was still not recognizable enough: only six percent of participants identified it correctly. Thirty-two percent of participants recognized it as “Wi-Fi” and 26.7% of participants identified it as “Voice” because of the sound waves. About 60% of participants recognized the “Phone Call” icon as “Wi-Fi” or “Voice,” and their confidence level was between “Somewhat Confident” and “Confident.” The “Message” icon was recognizable for most of the participants (96.6%), followed by the “Browser” icon with a correct recognition rate of 88.9%. Both the “Email” and “Camera” icons had correct recognition rates of around 81%.

Table 3. Recognition of the Form Reduction Style Icon and Confidence Level

	Phone Call	Message	Email	Camera	Browser
Recognition	6.2%	96.6%	80.8%	81.1%	88.9%
Confidence Level	1.3187	2.0440	1.2617	1.3010	1.3005

3.3 Demographic Information and Icon Recognition

The one-way ANOVA test was used for examining whether there were any significant differences between the means of two or more independent groups (Howell, 2002). To examine the study question: how demographic backgrounds influenced icon recognition, one-way between-group ANOVA tests were conducted using data from the Phase 2 study in SPSS. One-Way between-group ANOVA tests were conducted with the correctness of icon recognition as a dependent variable with age, gender, educational background, language, and use of phone brand as independent variables. Results were interpreted using a significance level of $p \leq .05$ to test the effects.

Educational background matched with age groups; the group of ages 18 to 24 matched with undergraduate students and the group of ages 25 to 34 matched with graduate students. Ages between 18 to 24 recognized the outline style “Browser” icons better than ages between 25 to 34. Data indicates that age group significantly affected the results with significant p value: .001 for the “Browser” icon. However, in general, age was not a factor in recognizing the two sets of icons.

The statistical results calculated by SPSS showed there was a significant relationship ($p=0.001 \leq .05$) between icon recognition correctness and age, in terms of “Browser” icon recognition. More specifically, when seeing this icon, younger participants had a higher mean icon recognition correctness (0: wrong, 1: correct) at around 0.9, while older participants had a mean icon recognition correctness of less than 0.7, which indicates that this outline-style “Browser” icon assisted younger participants recognition better than for older participants. Also, different age ranges significantly affected icon recognition of the form reduction “Camera” icon with a $p = 0.000 \leq 0.05$. Again, younger participants also maintained a higher ability (mean \approx 0.9) to recognize this icon correctly than older participants (mean \approx 0.7).

Gender was an interesting factor in the two sets of icons. Females recognized the outlined style Email icons better than males with a significant p value of 0.038, while males recognized the form reduction style Message icon better than females with a significant p value of 0.029.

Language could be an important factor in the recognition of icons with somewhat abstracted forms. The majority of English speakers’ icon recognition was higher than non-native English speakers, mainly in the form reduction style Camera and Browser icons with a significant p value of .053 and .011 respectively.

There was a notable phenomenon surrounding icon recognition correctness of both “Email” icons in the outline and form reduction styles with regards to the participants currently-used phone brand. The ANOVA results indicated that Samsung users were significantly less likely to guess the meaning of the “Email” and “Message” icons correctly than users of other phone brands in outline style icons and the “Camera” icon in the form reduction style with a significant p-value of .061, .000, and .020 respectively.

In addition, the icon recognition correctness had a significant relationship with how confident participants felt with their answers. Participants were more confident recognizing the icon correctly or incorrectly, especially with the “Email” icon ($p=0.31$), “Camera” icon ($p=0.000$), and “Browser” icon ($p=0.000$). In the form reduction icon study, with the exception of the “Phone Call” icon, the other four icons’ recognition correctness had significant relationships with participants’ confidence levels: all the p values of these four icons were 0.000.

4 Discussion and Conclusion

Materialized drawing with filtered features works as an icon style when shared by different phone manufacturers. Complex details can become confusing at smaller sizes (iOS Human Interface Design Guidelines, 2015), and icons with uncombined or simple visual elements are easily recognized without unnecessary visual elements that could distract viewers (Colborne, 2011). This study examined at what point of simplicity viewers stop recognizing or feel lost in recognizing smartphone interface icons.

From the results of survey Phase 1, outline-style icons were identified as the most recognizable for a majority of the participants among five different style icons. The silhouette-style icons generally had the lowest recognition rate among participants because the objects shown in those icons did not have distinct shapes that would help participants interpret their function correctly. The form-reduction-style icons were still recognizable for participants, even though the visual elements in those icons were extremely simplified by removing the profile and showing only one feature of each object.

From the results of Phase 2, recognition of the form-reduction-style icons was similar to that of its corresponding outline-style icon. According to Peirce's semiotics model, the object shown in an icon signified the meaning and guided the viewers' interpretation (Peirce, 1931).

This study found that a simplified form with the necessary visual cues for the objects in the icons did not decrease recognition dramatically. However, when the object does not signify the meaning such as the "Phone Call" icon in this study, viewers will misinterpret the meaning of the icons. When icons and symbols became conventional, it would be difficult to change the meaning even though the element is secondary. When we look at an icon or object, what we see comes from our existing knowledge instead of only from our eyes (Horton, 1994,). Some icons' recognition was influenced by age, gender, language, or use of phone brand as seen from the results of the Phase 2 study. It seems that familiarity, as part of existing knowledge, played a role in icon recognition.

The recognition of the "Phone Call" icons in both the outlined and form reduction styles was low. The low recognition could be explained by Rungtai Lin: Icon recognition confusion falls into three types: (1) "Visual similarity (shape feature)", (2) "Conceptual similarity (image feature)", and (3) "Visual and conceptual similarity (function feature)". For the outline-style "Phone Call" icon, the low recognition could be caused by visual and conceptual similarity, since "Voice" and "Speaker" versus "Phone Call" yielded the same image at first glance, and they all shared similar functions. For the form-reduction-style "Phone Call" icon, its shape feature had visual similarity with "Wi-Fi" or "Volume" icons (Lin, 1994).

The results of this study suggest several practical applications for interface icon design: Use silhouette as the style of an icon only if the object shown in this icon has a distinguishable profile shape. The results of this survey were consistent and supported the literature review that icons with the silhouette-style need to have a distinguishable profile (Horton, 1994). If the object shown in an icon is not familiar to viewers, even though the object is shown with enough details, the icon could be recognized with a different meaning.

To create widely acceptable icons, icon recognition tests with diverse user groups will be necessary because when viewers see an icon, the decoding process includes connecting to their existing knowledge and experiences. The absence of participants with more diverse backgrounds was a limitation of this study. This study was completed with students from a Midwest university in the US. Since students in one university cannot represent the students at other universities, and students cannot represent people at different age ranges, the results cannot be used for a broader population. Also, color was not included in this study and color could be an element for icon recognition. The results and limitations of this study suggested several directions for future research. Most immediately, future research should take participants' emotional reactions into consideration. For example, future research could examine people with different personal backgrounds and how their preferences differ,

especially regarding icon styles including color, simplicity, and other design elements. Also, in a future study, the participants could be recruited from a broader population.

5 References

- Ankrum, D.R. (1999). Visual Ergonomics in the Office — Guidelines. *Occupational Health & Safety*, 68(7), 64-74.
- Apple Inc. (n.d). iOs Human Interface Guidelines. Retrieved February 1, 2019 from <https://developer.apple.com/ios/human-interface-guidelines/>
- Arnheim, R. (1974). *Art and Visual Perception: A psychology of the creative eye / Rudolf Arnheim*. (New version, expanded and rev. ed.). Berkeley: University of California Press.
- Colborne, G. (2011). *Simple and usable: Web, mobile, and interaction design*. Berkeley: New Riders.
- Cho, M, Kwon, S, Na, N., Suk, H., and Lee, K (2015). The Elders Preference for Skeuomorphism as App Icon Style. *CHI EA'15 Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (pp 899-904). The ACM Digital Library.
- Blissymbolics Communication International-Start. (n.d). Retrieved February 1, 2019 from <http://www.blissymbolics.org/>
- Colborne, G. (2011). *Simple and usable: Web, mobile, and interaction design*. Berkeley: New Riders.
- Howell, D. C (2002), *Statistical Methods for Psychology*. Pacific Grove, CA: Duxbury/Thomson Learning.
- Horton, W. K. (1994). *The icon book: Visual symbols for computer systems and documentation*. New York: Wiley.
- Lin, R (1994). A study of visual features for icon design. *Design Studies*, 15(2), 185-197.
- Mertz, N, Usabilla Blog. (n.d.) Retrieved February 1, 2019 from <http://blog.usabilla.com/author/nikolaj/>
- Pierce, C.S. (1991). *Peirce on signs: Writings on semiotic*. Edited by James Hoopes. Chapel Hill: University of North Carolina Press.
- Sengupta, A., Chang, K. T.T., Wan, M P-H., and Chua, W.Y (2015). Representation Strategies Adopted by Participants in a Population Stereotype Hunt: A Case Study for Icon Design. *CHI EA'15 Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 759-764). The ACM Digital Library.
- Torralba, A. (2009). How many pixels make an image? *Visual Neuroscience*, 26(1), 123-131. doi:10.1017/S0952523808080930

About the Authors:

Qing Guo: She earned an M.F.A in graphic design and an MS in Human-Computer Interaction. She is currently working at Eargo in California as a UX (User Experience) designer for medical device.

Sunghyun R. Kang: She is a professor in the Department of Graphic Design at Iowa State University. She is interested in evidence-based design and her research includes web design, visual communication, and human-computer interaction.