



UNIVERSAL LANGUAGE OF UNDERSTANDING



THE ULOU PROJECT

UNIVERSAL HEALTH CARE SYMBOLS

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Submitted to OCAD University in partial fulfillment
for the degree of Master of Design, Inclusive Design

Toronto, Ontario, Canada, 2016

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ABSTRACT

The purpose of this research is to understand what properties make an icon universal in its understanding. Health care facilities in Ontario, Canada use written signage to help visitors navigate around their facilities. Substituting written signage with universal icons can help to create a more inclusive environment as icons have the unique ability to transcend language. By helping visitors navigate around health care facilities independently, it is possible to help lighten the burden on health care staff and reduce patient anxiety for first time visitors.

One of the key insights that came from the research is a model of understanding that provides designers with a framework for designing icons where the aim is to achieve universal comprehension. This project also explores how a participatory action approach involving users can help to inform the design process.

Keywords:

Icon, health care, signage, wayfinding, participatory action research, universal understanding, inclusive design.

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throughout the duration of the program. Additionally I would like to thank all of the administrators who work tirelessly behind the scenes to make each day run smoothly.

Lastly I would like to acknowledge the Ontario Graduate Scholarship for providing me with financial assistance. I am so grateful for the support.

DEDICATION

I would like to dedicate this work to my Mother, who always instilled in me the value of hard work. Thank you for being such a wonderful role model.

I would also like to dedicate this project to my wife Tori Allen. Her enduring support, encouragement and continual faith in my work gave me the strength to keep going especially during those times of complete exhaustion. I am grateful for her patience and understanding in my compulsion to continually challenge myself as an artist and lifelong learner. I would also like to dedicate this book to my son Garvey. Maybe one day you might read this ... and maybe you might find it interesting. Regardless, I promise to be a loving, interested father.

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THE STORY

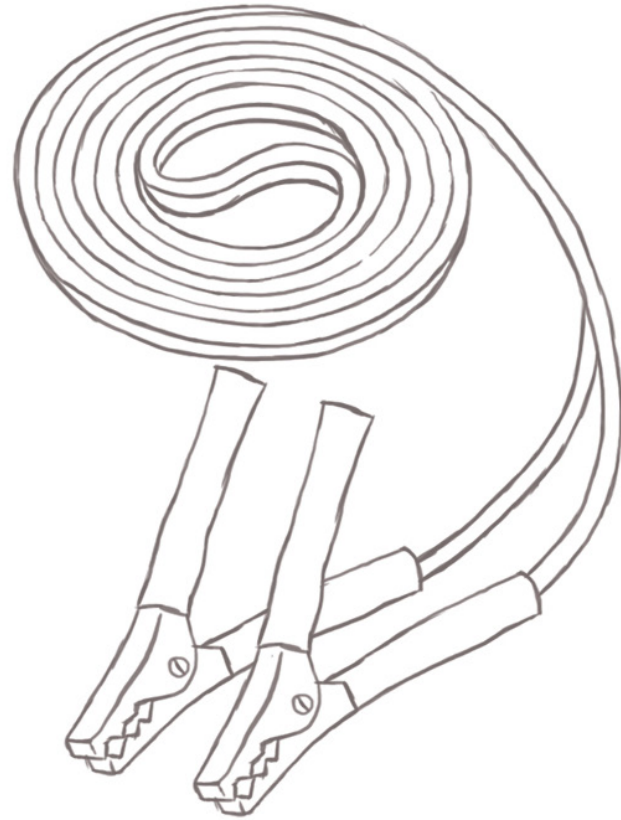
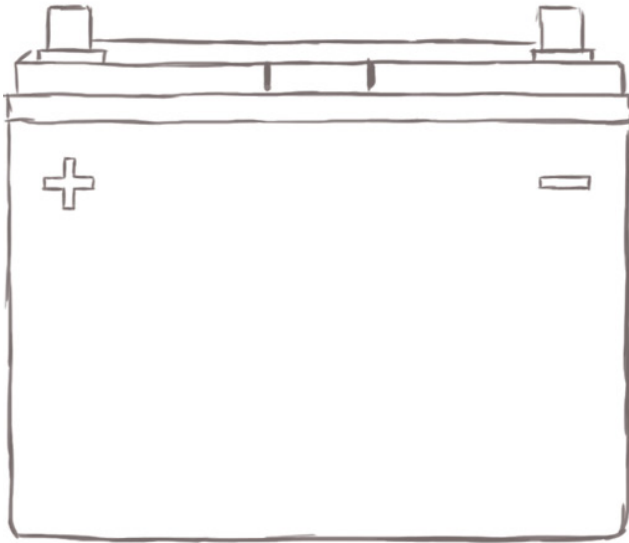
This story begins with a set of jumper cables. Actually, it's more about a drawing of a set of jumper cables.

I arrived in Seoul, Korea in August 2012 to begin a new adventure as the digital media art teacher at Asia Pacific International School. Shortly after arriving I embarked on a three-day camping trip with my wife and some new colleagues. On our last day, as we were packing up the car we discovered the car battery was dead; we had accidentally left an interior light on. Typically, a problem like this is easily fixed by getting a boost from a good Samaritan. The problem with our situation was that no one in our group spoke Korean and no one we encountered spoke English. We resorted to embarrassing charades and speaking really slowly, which is a common practice for many foreigners when they do not speak the native language.

In a naïve way, I assumed that wherever I traveled in the world, I would always be able to find someone fluent in English. This ignorant perspective turned into a very humbling experience as we sat stranded for two hours trying to figure out a solution, slowly watching the sun go down and running low on provisions.

After exhausting our efforts, I took out my sketchpad and drew a car battery and some jumper cables. The second person I showed my drawing to recognized immediately that we needed cables and a boost. Twenty minutes later we were on our way.

The solution to our problem came in the form of a simple drawing. The drawing served as a catalyst and sparked my interest in the field of semiotics and effective forms of visual communication, on which this major research project is based.



Jumper cables and battery: Illustration by Jeffery Woodrow

IDENTIFYING A PROBLEM

In January 2016, my wife and I were blessed with a beautiful baby boy named Garvey Kenneth Michael Woodrow, who was born at Soon Chun Hyang University Hospital (SCH) in Seoul Korea. Prior to the arrival of Garvey, my wife and I would make frequent trips to the hospital for various checkups and appointments. On occasion, I would have to leave work early to meet my wife there but I would always end up getting lost at the hospital. SCH uses written signage in Hangeul (the Korean alphabet) to assist people with navigating around their facility. I, unfortunately cannot read Hangeul, so the signs were ineffective. I was always a little late for our appointments and I was also constantly asking health care staff for directions in the hopes they could assist me.

While I was back in Canada for vacation, I visited various hospitals and health care facilities around the greater Toronto area to conduct preliminary research. I observed the vast majority of facilities use written signage to help visitors navigate their facilities as well. I set up a meeting with Pat Clifford, the Director of Research and Innovation at Southlake Regional Hospital in Newmarket,

Ontario. Pat explained they use written signage because, unlike the department of transportation, for example, there is currently no standard set of universal health care icons available. Pat also acknowledged that written signage is exclusive and is not an effective means of communication for all people.

Health care facilities can be a stressful place and trying to navigate around an unfamiliar environment during a time of duress can cause additional anxiety. One study shows that individuals who cannot read written signage, often end up lost or wasting time by waiting in the wrong queues (Cowgill & Bolek, 2003). These inefficiencies place an additional burden on health care staff and can possibly lead to longer wait times.

By January 1, 2015, Accessibility for Ontarians with Disabilities Act states that public sector organizations in Ontario need to make public information and design accessible when asked. This means working with the person who is asking to figure out how to meet their needs as soon as possible. (Ontario Government, 2016)



Garvey Kenneth Michael Woodrow: Illustration by Jeffery Woodrow

THEORETICAL POSITION

Using icons as a form of communication can be more effective than written signage because icons have the unique ability to transcend language and can help to create a more inclusive environment.

Replacing written signage with a visual form of communication can help to increase the level of comprehension because an icon bears a visual resemblance to the subject from which one is attempting to derive meaning (Abdullah & Hübner, 2006).

TERMINOLOGY

Semiotics

Semiology, or semiotics, is the analysis of signs, symbols or icons and their use. In the field of semiotics, there are numerous terms used to describe different types of visual communication. This paper uses the following taxonomy of terms, based upon the work of professor Micheal Zender from the University of Cincinnati and his research involving icons in the medical domain .

Symbol

Image referring to something else – a referent.

Sign/Glyph

Non-representational symbol, arbitrarily assigned with a wholly learned connection to a referent.

Icon

Representational image requiring no special learning for a categorical referent. Icons are typically created in a consistent graphical style with simplicity of form, where the intended message is clear, unambiguous and generally well defined from the start of the design process (Zender & Cassedy, 2014).

Pictogram

A combination of symbols, icons, and glyphs used to communicate a narrative, story, or data set.

Picture

Representational image requiring no special learning for a particular referent.

Terminology

For the purpose of this paper, the term “icon” is the most apt definition because it is consistent with the terminology used in the design industry.

The Noun Project (www.thenounproject.com) uses “icons” submitted by designers around the world for its open-source project. The aim of *The Noun Project* is to help simplify communication across borders and around the world through visual communication in the form of icons.

The Accessible Icon Project is another example of a well known design initiative that also uses the term. (www.accessibleicon.org).

**EXISTING
WORK**

LITERATURE REVIEW

HISTORICAL BACKGROUND

The first known pictorial signs appeared in 30,000 BC in the form of cave paintings discovered at the Chauvet-Pont d'Arc cave in France. Although it is difficult to ascertain the true meaning and intention behind the hand drawn images, it is clear that the pictures on the walls of the caves did serve as a means of expressing an idea (Adams, 2011).

The innovation of the printing press in the 15th century set in motion a system of rapid reproduction where a single design could be

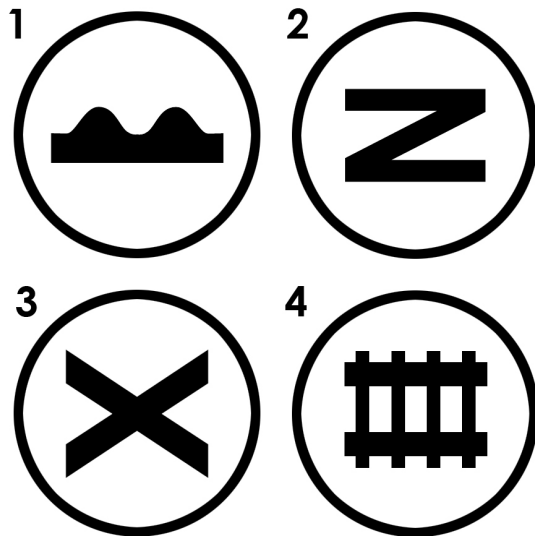
repeatedly printed and become commonly recognized. The earliest forms of pictorial icons could be found during this time in the form of small vignettes and ornamental designs that represented a trade or a family crest. Although not considered to be icons by modern standards, the elaborate designs were used as a tool to effectively communicate a message that did not involve a written language (Abdullah & Hübner, 2006).



Chauvet-Pont d'Arc cave replica. Fresco with rhinos.
Illustration by Jeffery Woodrow.

TRAFFIC SYMBOLS

The invention of the automobile and the rapid growth of the transportation industry in the early 20th century gave rise to a new form of specialized visual communication. In order to maintain order and establish a standard, the first pictorial icons in the form of traffic signs were internationally agreed upon and implemented in Paris in 1909 (Abdullah & Hübner, 2006). These road signs are still in use today in some parts of the world, suggesting that an icon with an established universal understanding is extremely valuable and can supersede the acceptance of new designs and ideas.



The earliest international road danger signs adopted in 1909. They indicate "bump"(1), "curve"(2), "intersection"(3), "railroad crossing"(4). Illustration by: Jeffery Woodrow.

OTTO NEURATH

In 1936, Austrian born economist and philosopher Otto Neurath developed the International System of Typographic Picture Education (ISOTYPE). Widely considered the grandfather of modern pictorial icons, Neurath developed and designed an international standardized database of public information symbols. He believed a pictorial sign should get straight to the point by removing unnecessary elements and only then can it assume its full iconic value. His simplistic geometric style had a major influence in the development of pictorial icons globally. Industries such as health care, transportation and tourism, and companies producing and shipping hazardous materials all began to see the advantages of swift communication through visual means (Abdullah & Hübner, 2006).



Illustration: Otto Neurath & Gerd Arntz. ISOTYPE collection.

OLYMPIC PICTOGRAMS

Although pictograms were first employed during the 1948 summer Olympics in London, the intention was not for them to be used as a visual form of communication, merely as complimentary illustrations. By the 1968 Olympic games in Mexico, pictograms were specifically designed to help minimize problems associated with linguistic based signs. These highly successful pictograms are aesthetically pleasing and use a simplified design with bold contrasting colours to convey information.



Pictograms from the 1968 Summer Olympics designed by: Manuel Villazon, Mathias Goerlitz, Lance Wyman, Eduardo Terrazas.

ARE ICONS EFFECTIVE?

Evidence suggests there are many benefits to using pictorial icons and that well-designed icons are generally recognized quicker and more accurately than written signage. (Edworthy & Adams, 1996).

There are four distinct advantages to using icons over written signs:

Universality

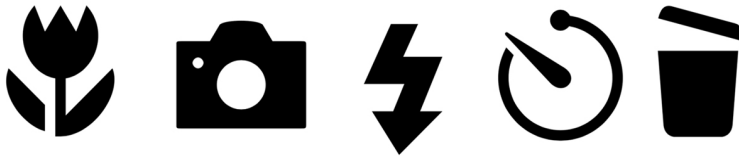
Effective icons need to be able to transcend the limitations imposed by verbal language. There are many examples of universal icons being used daily that are understood across cultures. Examples include icons used in airports, road signs, washing instructions for garments and warning labels.



Globally Harmonized System of Classification and Labelling of Chemicals (GHS): From left to right, explosive, toxic and flammable. Illustrations by GHS.

Spatial affordance

Icons can be presented in a much more spatially condensed form than most written signage (Zwaga & Boersema, 1983). Examples include smart phones, mobile media devices and digital cameras that take advantage of limited display space by using icons to communicate information.



Digital camera icons by Thomas Helbig

Inclusive Design

Substituting written signage with graphic icons can be more inclusive because text requires the interpreter to be able to read and comprehend the language presented to them. Icons have the ability to benefit individuals who are illiterate as well as non-native speakers.

Recognition

Human factors research has demonstrated that graphic icons can be more easily and rapidly recognized at a greater distance (Dewar & Ells, 1974). 90% of information transmitted to the brain is visual. Visuals are processed 60,000 times faster in the brain than text (Forrester, 2012).

Dual-coding theory postulates that there are two ways a person could expand on learned material: verbal associations and visual imagery. (Sternberg, 2003). When icons are used together with words they are stored in both the visual and verbal memories. These memories are tightly linked to one another and help strengthen the meaning (Horton, 1994).



When driving at high speeds, the road sign on the right is much easier to interpret than the sign on the left. Removing text also makes the sign more inclusive. Illustration by: Jeffery Woodrow.

DISADVANTAGES

The development and use of effective icons as elements of communication requires good design and thorough evaluation (Collins, 1982).

Rudolf Modley, the author of *The Handbook of Pictorial Symbols*, found that administrators like to select icons that have been used previously by others and which have presumably already been accepted by the public. He believes this has led to the widespread adoption of many illogical or ambiguous icons (Modely, 1976).

One barrier with using icons as a form of communication is that the meaning can be interpreted in different ways. Unlike verbal language which has a set of syntactic and semantic rules that help us understand the meaning, pictorial language, as of yet, has no equivalent universal rules underlying its comprehension (Rogers, 1989). Thus, in instances where precise interpretation is required, icons can be ineffective.

MISUNDERSTANDINGS

One reason why icons are often misunderstood is because they are poorly drawn, or drawn from an uncommon perspective. An example of this is the “inflate tire” icon found in most cars, which according to one study, could not be identified by one third of drivers. (Woodyard, 2010).

Disparity in familiarity with various technologies across the globe is another factor (Zander & Cassidy, 2014). For example, Magnetic Resonance Imaging (MRI) is available at most hospital in North America, but may not be available in some developing countries. Someone who does not understand what an MRI is will certainly not understand the corresponding icon. As James Mangan stated, “correct interpretation of these signs requires exposure to what they signify” (Mangan, 1978).



The inflate tire icon on the left is drawn from an uncommon perspective and is not easy to identify. This icon for “MRI” uses Roman characters, which are not recognized in some parts of the world. Illustration by: Jeffery Woodrow and Hablamos Juntos in partnership with JRC design firm.

CASE STUDY: HABLAMOS JUNTAS

The Hablamos Juntas Foundation is an American organization that helps improve communication between health care providers and members of the Latino community with limited English proficiency. Limited English proficiency refers to a person who is not fluent in the English language, often because it is not their native language. The Robert Wood Johnson Foundation and JRC Design firm took on the challenge of improving wayfinding systems in health care facilities for individuals with LEP.

According to Ravi Poovaiah and the *Theory of Signage*, research has shown that 35-40% of first-time hospital users end up waiting in the wrong queues and patients often wait over half an hour before realizing this error (Poovaiah, 2003).

The first step was to identify the top 30 referents most often used in health care facilities. A referent is a real world object, place or concept that an icon is meant to represent. The team used a survey designed to identify the 30 most common destinations in health facilities. Seven graphic designers from around the country then worked to design and test candidate icons. (Poovaih, 2003).

The Goal

The goal was to help individuals with limited English proficiency navigate around health care facilities by developing wayfinding icons that would be effective for the broadest possible group of people. To achieve the goal, the team tested the icons with people from various cultures and ethnic backgrounds.

Research Methods

The icons were tested through a survey method called *Comprehension Estimation Testing*, which has been used in many different countries and adopted by the *International Organization for Standardization (ISO)* because it produces consistent and reliable results.

Three hundred participants speaking English, Spanish, other Indo-European languages and Asian languages provided input on the comprehension value of the newly designed universal health care icons.

To compare the new icons to typical written signage, the Society for Environmental Graphic Design (SEGD) worked with a wayfinding consultant to pilot test the icons in four hospitals around the country.

RESULTS

Upon completing the research, a new set of health care icons were designed and placed in local hospitals to help assist LEP patients with independent navigation. According to the study, the results were positive:

- More than 75% of people who tested the new icon system felt the icons were more effective than text-based signs. Feedback suggested that icons were easier to see and understand and were even preferred by English readers (Cowgill & Bolek, 2003).
- More than 80% of hospital staff interviewed after the implementation of the project felt the new icons helped to ease the process of giving directions to patients and visitors (Cowgill & Bolek, 2003).

ACQUIRED KNOWLEDGE

The development of a cohesive icon system, particularly for the health care industry, is a controversial undertaking in the design world. The paramount goal was to create an icon set that was simple, uniform, distinctive and clearly understood. The icons needed to have graphic clarity in order to convey the intended message.

In the end, this work confirmed that a thoughtful and well-designed icon set can benefit both individuals with limited English proficiency and native English speakers. Icons are not the solution for a poor signage system, nor will they alone solve wayfinding issues. However, they can be a part of a viable and dynamic system to assist all people to feel more comfortable and confident navigating within a health care facility (Cowgill & Bolek, 2003).



Pharmacy



ICU



Alternative
Medicine



Kidney



Oncology



Surgery



Anesthesia



Chapel



Diabetes



Women's
Health



Health
Educatio

Examples of icons designed by Hablamos Juntos & JRC Design firm.

GAPS IN THE RESEARCH

With regards to icons, some concepts seem to be communicated more clearly, while others are still murky. An example is the action to *push* or *pull*, which has proven difficult to illustrate as an icon and continues to defy obvious graphic delineation (Dreyfuss, 1972). There is a vast difference in representational approaches for some ideas, but more universal ones for other concepts.

In 2013, 10 years after the Hablamos Juntos Foundation created their universal health care icons, researcher Michael Zender tested the same 54 icons across cultures to understand if they were truly universal. To avoid cultural subtlety and to draw on two very different cultures, the study was conducted in the urban city of Cincinnati, Ohio in the United States and the rural African village of Shirati in Tanzania. The aim was to test comprehension levels across these vastly different cultures.

Findings

Zender discovered that only 8 of the 54 icons tested were successfully identified in both countries. According to the ISO, the benchmark to

determine successful icon comprehension is an 85% recognition rate (Department of Transportation, 2004). From his previous research, Zender observed that some medical icons failed because the viewer was unfamiliar with the medical concept or the cultural reference being represented (Zender & Cassedy, 2014).

Examples

- A 'CT scan' is not a standard practice in Tanzania and the general public is unaware of this technology.
- The teddy bear used in the 'pediatrics' icon is not a cultural reference understood in Africa.
- The dollar sign used in the 'billing' icon is not a symbol recognized in Tanzanian culture.
- In Tanzania, the cross in the 'medical library' icon is more closely associated with religion than with health care and feedback suggested it looked like a person reading a bible.



CT Scan



Pediatrics



Billing



Medical Library

Symbol Illustrations: Hablamos Juntos & JRC Design firm.

THE RESEARCH

ADVANCING THE RESEARCH

RESEARCH QUESTION:

How can an icon be designed to more effectively transcend cultural boundaries?

There are a number of incentives for health care facilities to adopt a global set of health care icons. By helping people navigate around facilities independently, the icons have the potential to:

- Lighten the burden on health care staff
- Lower patient anxiety for first time visitors
- Create a more inclusive environment for English language learners or individuals with limited English proficiency
- Help reduce hospital wait times

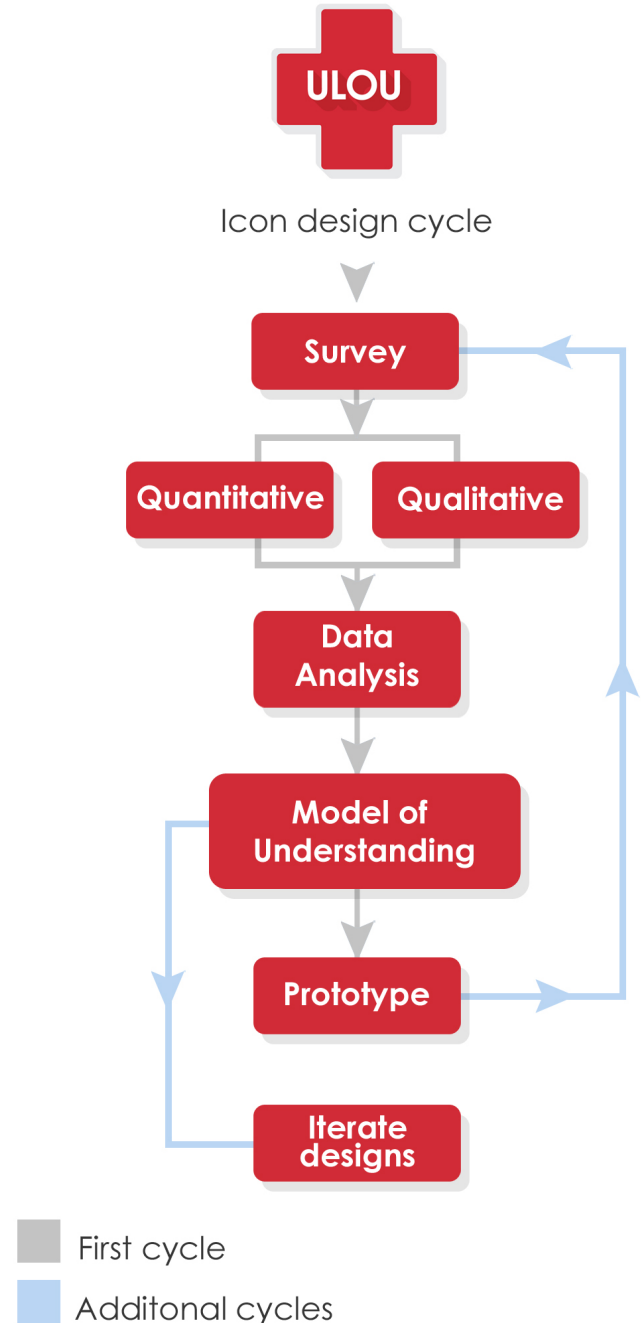
Transportation hubs, such as major international airports, all use icons to help direct people to their desired destinations. The Hablamos Juntos Foundation produced very positive results with their research and the development of their icons. The aim of this research is to add to the existing work.

THE DESIGN CYCLE

In order to produce a more universal representation of an icon, an understanding of what properties make an icon “universal” is required to help guide the design.

The aim of the research is to develop a model of understanding by getting feedback from a diverse number of people from different ethnic and cultural backgrounds about what different icons represent and what makes an icon universal in its comprehension.

The model is intended to help designers understand how people interpret icons and will provide recommendations and guidelines to help inform future designs in creating icons that are more universal in their representation.



DATA COLLECTION: THE SURVEY

Tools

An online survey was created and approved by the Ontario College of Art and Design, Research Ethics Board. All responses were anonymous, no IP addresses or personal identifiers were collected.

Recruitment

In order to recruit a diverse number of participants, an email was sent to health care facilities around the globe. The first point of contact was the facilities operations manager and the accessibility officer (where applicable) responsible for signage and wayfinding systems. Upon establishing a point of contact, a request was made to forward the link for the survey to all people in their networks.

An additional email was also sent to colleagues in the Master of Design, Inclusive Design program at OCAD University.

Participants were given as much time as needed to complete the online survey, which I estimated to be 12 - 20 minutes.

Participation

In total, 134 people participated in the study. Participants were asked to optionally provide their ethnicity. The ethnicities provided include:

- American
- Canadian
- European
- Hispanic
- Russian
- Ukranian
- Australian
- Chinese
- Filipino
- Italian
- Scottish
- Welsh
- British
- Emirati
- German
- Korean
- Slovenian

The survey used a series of open-ended questions divided into three parts.

Part 1:

The first question probes understanding into the meaning of the icon. My hypothesis was that if participants were presented with multiple icons, all with the same intended message, they would use all of the icons collectively to help ascertain the meaning. Thus, participants were presented with only one icon and were asked to identify what the symbol meant to them. Upon completing part one, participants proceeded by clicking on the “next” button and were directed to part two.

Part 2:

The second part of the question probes understanding into quality and aims to identify what characteristics make a particular icon more apt in representing a referent.

In this section, participants are informed of the intended message of the icon from the previous slide. Participants are then presented with multiple icons all with the same intended message and are asked to select which icon best represents the referent.

Upon completing part two, participants proceeded by clicking on the “next” button and were directed to part 3.

Part 3:

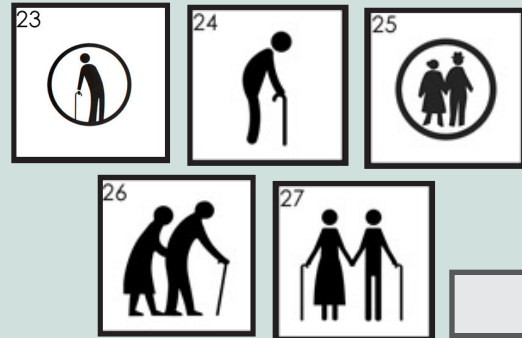
The last section asks participants to pick their preferred style of design regardless of effectiveness and explain why.

An excerpt from the ULOU survey

1. What does this icon mean to you?



2. The intended message for the icon on the previous screen was *Geriatric/Elderly*. What icon do you think is most effective at representing *Geriatric/Elderly*?



3. Regardless of effectiveness, what style of icon do you prefer? Why?

DATA ANALYSIS

QUALITATIVE DATA ANALYSIS

Data analysis

In part 3 of the survey, participants were asked to select their preferred icon of choice regardless of effectiveness and give a rationale for their decision. A total of 1123 open-ended questions were analyzed, and 7 themes were identified.

The responses were imported into a spreadsheet and each response was assigned a letter that represented a theme. Multiple letters were given to answers that touched on multiple themes.

Identified themes

H	Humanistic: Designs that show compassion and a sense of dignity and connect with people on an emotional level.
G	Graphic style: Consistency in graphic style; aesthetically pleasing, impactful designs.
C	Clarity: Sense of clarity; simplicity and ease of interpretation using a precise amount of detail.
N	Neutral: Designs with both cultural and gender-neutral representations which convey a sense of equality.
R	Relevant: The most apt symbolic representation of the referent.
O	Other: Other thematic suggestions or unknown connections.
X	None: No established connection.

Response frequency

H	145
G	184
C	321
N	96
R	325
O	63
X	70
SUM	1204

Portion by percentage

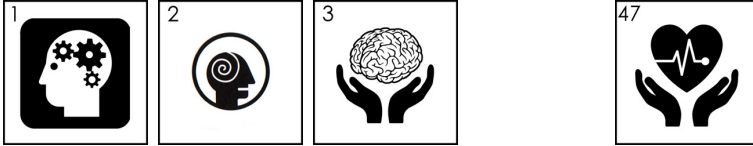
H	12%
G	15%
C	27%
N	8%
R	27%
O	5%
X	6%
SUM	100%

DATA MINING: VISUAL DATA CLOUD



QUANTITATIVE DATA ANALYSIS

Empathy & Emotional Connection



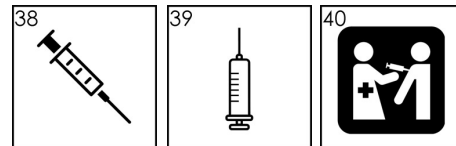
The three icons used in the survey to depict mental health. Icon 47 represents cardiology.

What icon do you think is most effective at representing <i>Mental Health</i> ?		
1	2	3
32.26%	22.58%	45.16%

Regardless of effectiveness, what style of icon do you prefer?		
1	2	3
53.66%	19.51%	26.83%

Although there was a preference for the graphic style of icon 1, icon number 3 was selected as the most effective representation of mental health. Participants noted that the gears used to depict *mental health* felt too mechanical and did not convey a sense of warmth. Additionally, participants also noted that icon number 2, which uses a swirl, implied neurosis and again was perceived to be negative. On the contrary, participants stated that the hands in icon number 3 helped to create a sense of compassion and caring. The same sentiment was echoed for icon 47 representing *cardiology*.

Positive Association



The three icons used to depict immunization.

What icon do you think is most effective at representing <i>Immunization</i> ?		
38	39	40
30.63%	8.11%	61.26%

61 % of participants preferred icon number 40 as the most effective representation for immunization. Feedback suggested that the health care staff administering the needle was a much more positive association and conveyed a message of support.

Conversely, an isolated needle on its own created a negative association with fear for individuals afraid of needles. The image of a needle on its own was also not the most apt representation as it was repeatedly associated with a safe injections site.

Clarity & Simplicity



The two icons used in the survey to depict mammogram

What icon do you think is most effective at representing Mammogram?	
9	10
57.63%	32.37%

58% of participants selected icon number 9 as being the most effective at representing *mammogram*. Participant feedback suggested that design number 10 was too complicated, and the rings were associated with radiation, which was perceived to be negative. Participant responses suggested that icon 9 was clear, simplistic in design and easier to digest visually.

Level of Detail



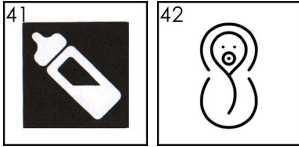
Two icons used to depict laboratory and heart monitor

Regardless of effectiveness, what style of icon do you prefer?	
11	12
72.88%	27.12%

73% of participants preferred the design style of icon number 11 over icon 12. Participants stated that icon number 12 looked like a cartoon illustration and contained unnecessary detail.

Too much detail can be confusing, however just the right amount of detail is pertinent to successful comprehension. Participants noted that while icon number 46 effectively conveyed *cardiology*, the additional detail of the added screen in icon 48 changed the meaning from *cardiology* to *heart rate monitor*.

Culture/Gender Neutrality

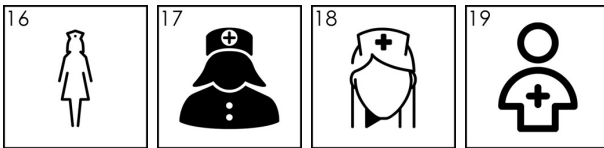


The two icons used to depict nursery.

What icon do you think is most effective at representing Nursery?

41	42
36.94%	63.06%

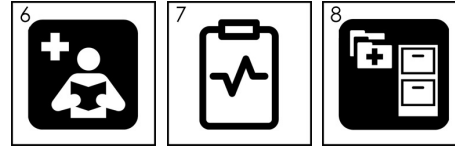
A preference towards icons that are culturally neutral was illustrated in the icon test for *nursery*. 63% of respondents found icon number 42 to be more effective at communicating *nursery*. Participants suggested that using people over objects in the icon can create a stronger connection. Some participants voiced concern that the icon of a baby bottle may not be universally understood, as some cultures do not use bottles to feed newborns.



The four icons used to depict nurse.

70% of participants chose the gendered icon as the most effective, yet 49% of participants stated that icon 19 was preferred because it was the only option that was gender-neutral. The notion that only women are nurses and men are doctors was deemed to be offensive by many participants.

Relevance



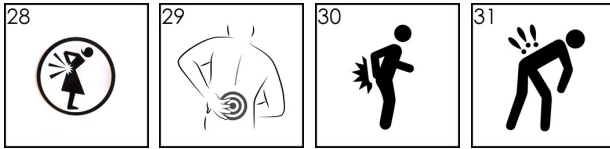
The three icons used to depict medical records.

What icon do you think is most effective at representing Medical Records?

6	7	8
6.78%	27.97%	62.25%

62.25% of respondents selected icon number 8 as the most effective at representing *medical records*. Upon analyzing the responses, participants stated that icon 6 appeared to look more like someone reading a book and was not effective at communicating the intended message. Icon 8 is comprised of two symbols, the folders and the filing cabinet, and the added detail was a factor in helping to improve the comprehension rate. More importantly, responses suggested that this referent was a more apt representation of *medical records*. Although traditional paper filing cabinets are becoming obsolete, the representation is still commonly understood. Participants noted that the cross on the file folder was a necessary addition to help establish a connection to the health care industry.

Emphatic lines



The four icons used to depict back pain.

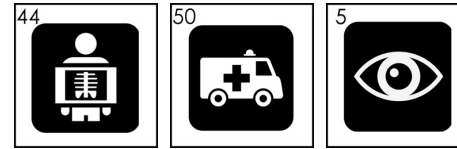
What icon do you think is most effective at representing Back Pain?

28	29	30	31
54.87%	24.78	15.04%	5.31%

55% of participants found icon 28 to be the most effective at representing *back pain*. Participants noted that the additional emphatic sharp lines were very helpful for indicating the specific area of pain.

Participant feedback stated that the exclamation marks in 31 and the rings in circle 29 were ambiguous, and that icon 30 appeared to represent flatulence.

Graphic Style



Three high contrast icons use a soft box to add definition.

60% of participants chose a specific design style when asked what design was most preferred regardless of referential effectiveness. The preferred design style of choice uses a bounding box and graphics of high contrast with geometric shapes to depict information. Contrast refers to the brightness and darkness of an image and the state of being strikingly different

Participants found the bounding box to be an important feature because it helped to contain the message and the high level of contrast makes it easy to see from a distance.

Respondents noted that consistency in design style is a critical factor in creating a collection of icons.

DISCUSSION

DISCUSSION

The goal of creating a universally understandable icon set is a wicked problem. The effort to solve one aspect of where an icon may fall short reveals or creates other problems in a new iteration.

For example, the “elderly” icon, which uses two people in the design (icon 27, page 35), created a positive emotional connection for individuals who perceived that the icon demonstrated compassion and companionship. Conversely, many participants also felt that the representation of two people may be a trigger for someone who has lost their partner in life and this could potentially elicit a negative response.

Variables such as culture, gender, age, education, exposure and ethnicity are just some of the many factors that need to be considered.

Although the survey conducted for this research project involved a relatively small sample size, results show that design preferences do exist and there are key elements that can help improve comprehension rates. The data collected suggests the most preferred icons established positive emotional connections.

The research conducted is consistent with the *Universal Principles of Design*, which states that perceived positive relationships with a design can help evoke feelings of affection, which has a direct correlation to the long-term usability and overall success of a design (Lidwell, 2003). Participants expressed a preference for icons that conveyed a message of empathy, such as how Icon 3 (page 40) depicts *mental health* with hands holding and supporting the brain.

Finding the most apt representation is the first challenge for icon designers. This becomes increasingly more difficult when attempting to represent abstract concepts or ideas, rather than a specific person, object or action. For example, the term “cancer” is an abstract concept and is difficult to represent because there are many different types of cancers.

Recognition and Stereotypes

In recent years, the International Organization for Standardization (ISO) has been criticized for continuing to use the *International Symbol of Access*, which depicts persons with mobility issues as being static and passive. An updated design created by the Accessible Icon Project depicts the individual in the wheelchair in a more active position.

Barry Gray, Chair of the ISO Committee on Graphical Symbols, stated that the new symbol made him think of Paralympic athletes, of wheelchair races and speedy movements. He believes the symbol has to work in static situations and has to mark accessible routes, like ramps and lifts, which are not designed for speeding. Mr. Gray fears the proposed symbol could give a misleading impression and believes the long history of the symbol and instant recognition makes up for any design flaws (Lazarte, 2003).



The International Symbol of Access and the newly designed symbol by Sara Hendren for the Accessible Icon Project. www.accessibleicon.org

The International Symbol of Access was designed in 1968 by Danish design student Susanne Koefoed, and is still the only version endorsed by the International Organization for Standardization. (Guffery, 2015).

There are numerous icons that rely on stereotypes to help convey a message. Notable examples include the gender stereotype that depict men as doctors and women as nurses. According to the ULOU survey, 70% of participants chose an icon that depicts a nurse as female as being the most effective representation compared to just 30% who selected the gender-neutral option. (page 42, icon 19). However, almost half of participants were dissatisfied with the stereotype as stated in their response. This poses an interesting conundrum, as the very property that caused its dissatisfaction is linked to its recognizability.

Icon acceptance is comprised of two key elements:

Acceptance = Exposure + Time

The Geospatial Information Authority (GSI) of Japan recognized that its national pictogram system was not very friendly to foreigners (Rhodes, 2016). In 2020 Tokyo will be hosting the Olympics and expects a large surge in tourism. The GSI proposed some changes, and after conducting research, they created a series of new, very literal pictograms. The new icons include overhauled versions of particularly confusing icons (Rhodes, 2016).

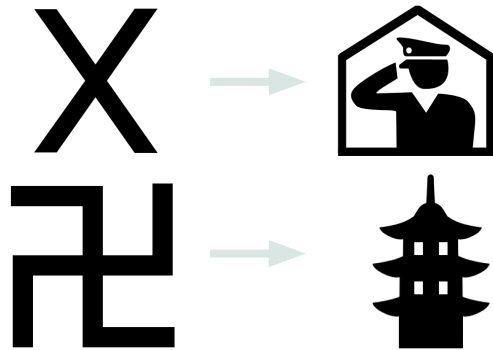


Illustration recreation by Jeffery Woodrow.

“The old sign for a police station was a letter ‘X’, which symbolized batons crossing. The new one is a police officer. Buddhist temples will now use a pagoda instead of the backwards swastika. The use of the swastika makes sense when you realize the symbol means “good fortune” and is common in Buddhism, Hinduism and other religions; however, this usage is not as familiar to western tourists” (Rhodes, 2016).

AN INCLUSIVE APPROACH

As the world changes at such a rapid pace, icons also need to evolve and adapt. Instead of aiming to create a truly universal icon set, it might be more advantageous to empower people with the tools and resources they need to fulfill their own diverse needs.

A more adaptable approach could become a more inclusive approach. In order for this approach to be implemented, it is necessary to add a new element to the equation:

$$\text{Acceptance} = \text{Exposure} + \text{Time} + \text{Accommodation}^*$$

*Accommodation = Ability to adapt, modify, change, grow, evolve, revise, suit and respond.

**TYPOGRAPHY AS
DESIGN**

Global acceptance through global participation

In order for this project to have a positive impact globally, people from all over the world must give input. Participatory Action Research, also known as PAR, is a research method where the objective is to make a positive difference while improving the lives of those involved in the research by collaborating with them as co-researchers (Baldwin, 2014).

The PAR perspective is that all knowledge is socially created. By conducting research with people instead of on them, PAR seeks a participatory process through creative collaboration that uses cycles of reflection and action to create new forms of knowledge. The end goal is to show people how the world could be and not just how it is.

The ULOU project supports an open-source model where users can participate in the project by contributing ideas, providing feedback and designing icons. By empowering people with the tools and resources to expand, modify and adapt the project to suit their own diverse needs, there is a greater chance the ULOU health care icons will be more accessible and benefit a greater number of people around the world.

A PAR approach has the added impact of removing power differentials. Subject participation is also more likely to generate a sense of ownership and ensure the outcomes of the research are “empowering and sustaining” (Bradburry & Reason, 2008).

Data from the research conducted from this study suggests that icons that are perceived to be part of a larger set are preferred. Icons that share a similar design style and characteristics are important considerations for universal acceptance. One of the greatest challenges with a PAR approach to designing new icons is to ensure that there is a consistent uniform style.

TYPOGRAPHY AS DESIGN

By establishing guidelines developed through the research and by placing confines on the parameters of the design, it is possible to ensure distinct uniformity. The ULOU set of health care icons has been designed entirely using the typeface Century Gothic.

The typeface is a geometric sans-serif font created by Monotype imaging. It is strongly influenced by the common typeface *Futura*.

Why Typography?

- Provides a basic framework with constraints and confines to help guide the design process.
- Ensures consistency in line, weight shape and style.
- It is an easily accessible commercial font.
- TrueType fonts (TTF) are resolution independent and can be easily prepared for vector output, which helps to ensure a level of high quality.
- TTFs work on various operating systems.

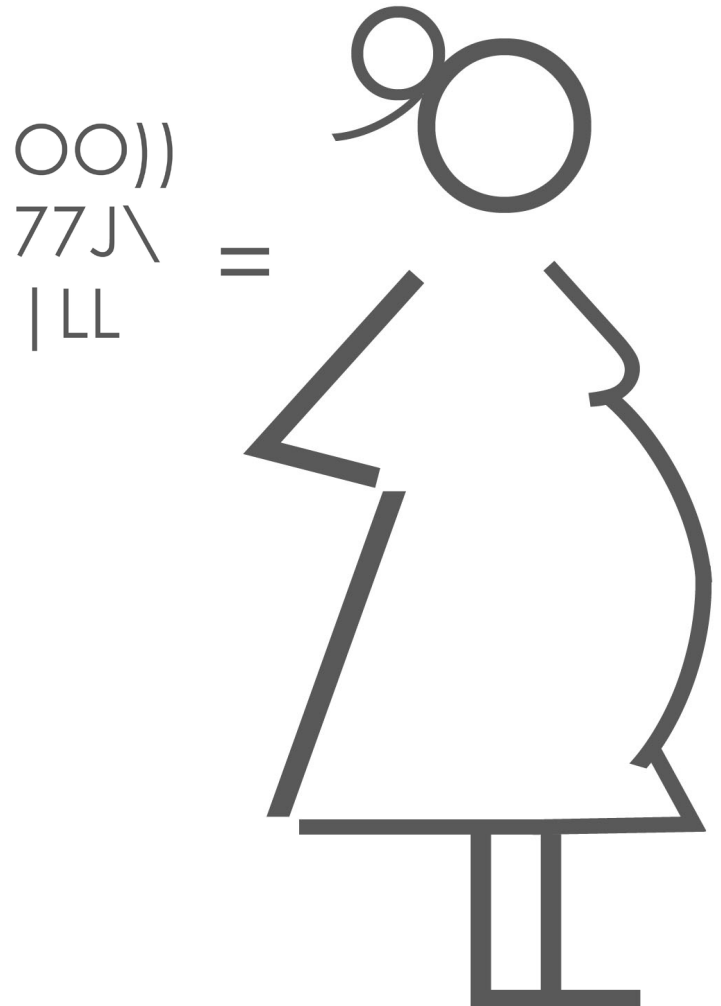
Guidelines

- Letters can be cropped where necessary
- Letters can be flipped horizontally and vertically
- Letters can be proportionally scaled
- Line weight should be 1/20th of the design space and consistent throughout the design.
- Characters can overlap, intersect or remain independent from one another.

License

Century Gothic is currently licensed to Microsoft as part of their font family and is found on computers that use Microsoft products such as Word, PowerPoint and Excel.

There are a total of 95 printable *Century Gothic* characters found on a standard QWERTY English keyboard. All of these characters can be used to help create the icons.



Maternity Icon. Illustration by: Jeff Woodrow

MODEL OF UNDERSTANDING

MODEL OF UNDERSTANDING

Level 1: Design

Elements of Design: The tools to make icons

Line

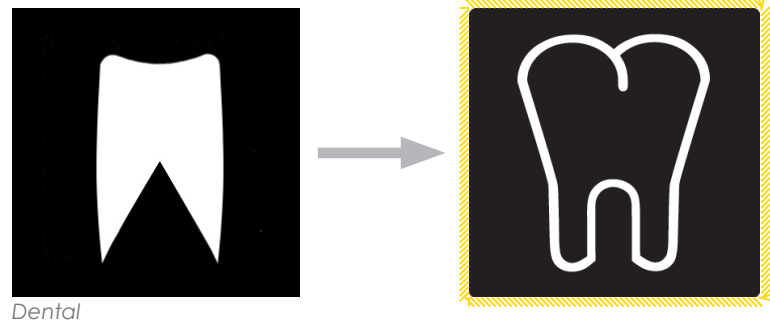
Optimal line thickness is about 1/20th of the defined square format. This creates good visibility but also leaves enough space for the motif to be clearly defined within its frame (Abdullah & Hübner 2006). Consistency of line thickness helps to ensure uniform representation within an icon system.

Shape

My research found a preference for icons designed with soft rounded edges. Participants stated that rounded edges provided a sense of ease and comfort. My research was also consistent with *contour bias theory* from Lidewell, which states that curved contour objects are more effective at making a positive emotional impression than sharp angular lines (Lidwell, Holden & Butler, 2003)

Space

A bounding box should be used to help contain the icon. A box with rounded corners can help to increase the contrast and it also prevents icons that have been placed beside one another from inadvertently being read as one.



Level 1: Design

Principles of Design: How to use the tools

Contrast

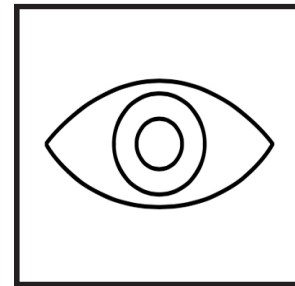
For optimal contrast, a white icon on a black background works best. Avoid using multiple colours, transparency effects, halftone patterns or shading. Icons of high contrast are also more accessible for individuals who are visually impaired because they are easier to see from a distance.

Emphasis

Additional action lines can be a good way to emphasize action. Examples such as sharp triangles or radial curves can help add emphasis to a design. Fewer details are not always better but too much detail can create confusion. The aim is to find balance.

Harmony

A visual hierarchy of icons exists within an icon. Changing the size to make the primary icon larger and by placing it at the top of the visual hierarchy and supporting icons at secondary levels might help to produce more accurate comprehension. The designer should consider the desirable reading sequence of the icons and determine the visual hierarchy when multiple icons are used in one icon (Zender & Cassidy 2014).



Eye care



Hearing



Heart monitor



Level 1: Consistency

Common visual rhythm

Consistency

Designs must have a common visual rhythm and each individual icon must fit within an overall pattern. A visual balance creates a sense of harmony and icons are more effective when they are perceived to be a part of a larger collection.



Geriatric



Level 2: Connectivity

Emotional connection

Positive emotional connection

When possible, an icon should attempt to go beyond conveying a message and aim to establish a positive emotional connection through designs that demonstrate empathy and understanding. During stressful situations positive relationships can act as a catalyst for creative thinking. Conversely, negative associations dampen creativity, increase fatigue and lower cognitive performance. The aim should be to help reduce fear (Lidwell & Holden, 2003).



Relationship counseling



Level 2: Connectivity

Personal connection

People over objects and metaphors

When possible, use people over objects. Using figures in the design can help an icon become more universal because inanimate objects can often have different meanings to different cultures.

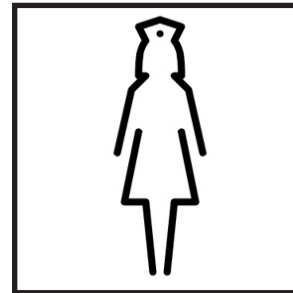


Nursery



Gender neutrality

When gender is not a requirement, gender-neutral representations are preferred. It is important to avoid sweeping generalizations and gender stereotypes. Icons have the ability to not only inform but also promote inclusivity and equality.



Health care staff



Universal understanding

If an icon is to be universal, it should aim to be void of cultural references. Refrain from using letters and numbers in the design when possible.



Emergency

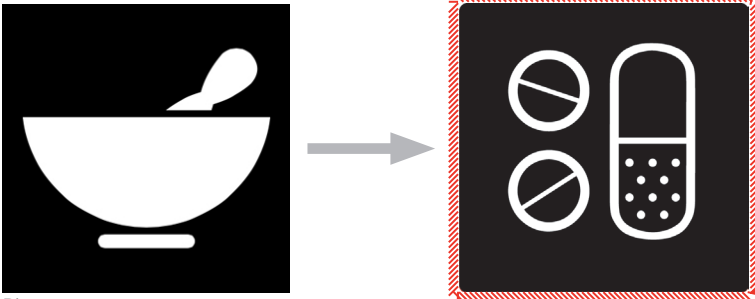


Level 3: Iteration

Test - Inform - Iterate

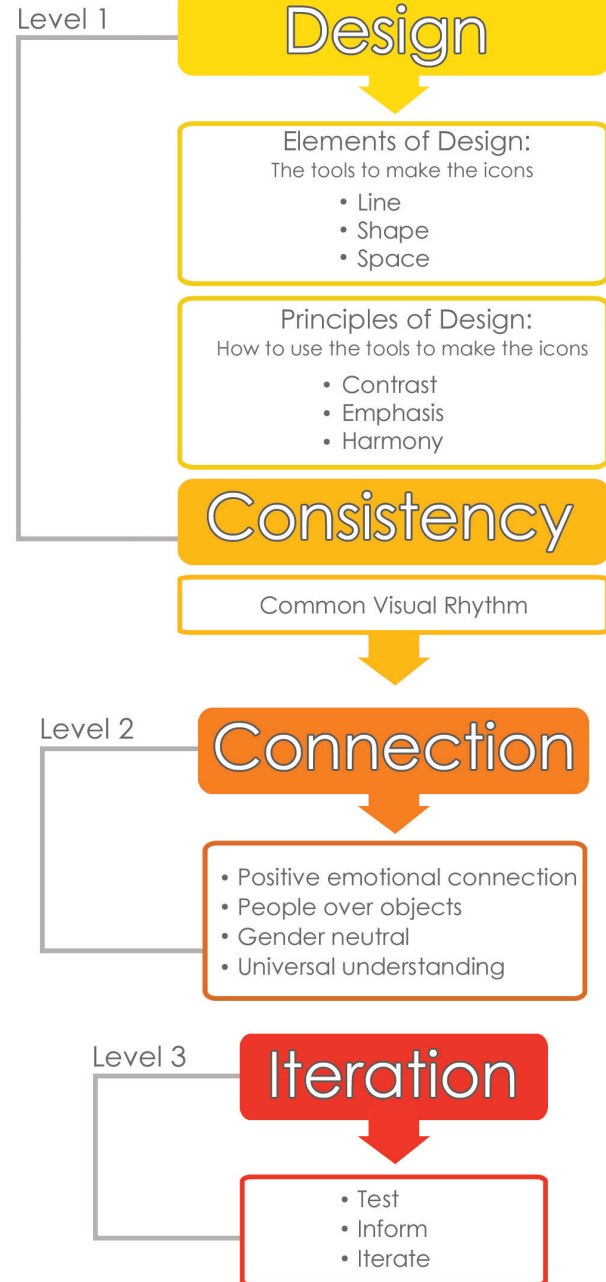
Testing and Iteration

Icons need to be tested on a diverse audience to determine their overall effectiveness and comprehension rate. Data from the research can then be used to help inform the design process.



Pharmacy

The Model



THE ARTIFACT

www.ULOU.org

THE ULOU HEALTH CARE ICON SET



Health care staff



Chest



Maternity



Nursery



Geriatric man



Respiratory



Accessible



Nasal



Geriatric woman



Kidney



Eye care



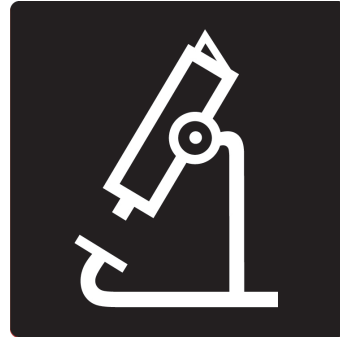
Ear care and hearing



Dental



Relationship counseling



Laboratory



Stethoscope



Optometry



Genetics



Heart monitor



Blood pressure



Pharmacy



First aid kit



Medical files



Broken bone and fracture

THE ULOU HEALTH CARE ICON SET



Emergency



Isolation



Gender-neutral



Safe injection site



Health care facility



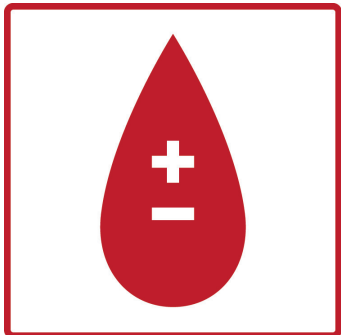
Pain



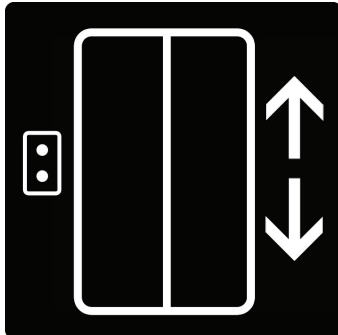
Woman



Shower



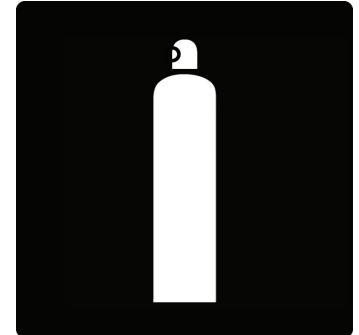
Blood



Elevator



Man



Oxygen

FUTURE DEVELOPMENT

MOBILE APPLICATION

NFC navigation system

The ULOU mobile application will be designed to work in association with the ULOU health care icons. The free mobile app will provide both visitors and patients with a directory of destinations specific to the health care facility they are at. Users will have the option to select their destination from a list, or enter a destination using the search function.

Each destination will have a corresponding sign with an icon. The signs will use *near field communication* (NFC) to communicate to a smart phone running the application. *Near field communication* is a set of communication protocols that enable two electronic devices to establish a connection with one another by bringing them within 2 inches of each other.

Upon selecting a destination, a floor map of the health care facility will be displayed and guiding arrows will help individuals navigate to their destination. NFC eliminates the need for a wifi connection and will allow the application to run independently. Global Positioning Systems (GPS)

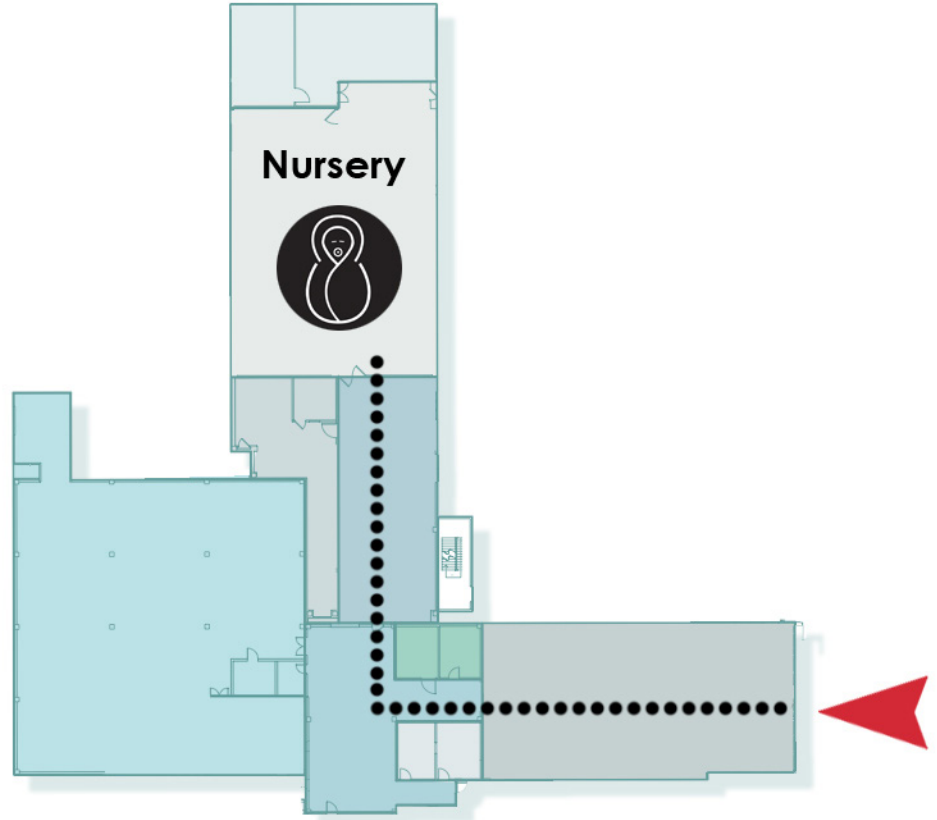
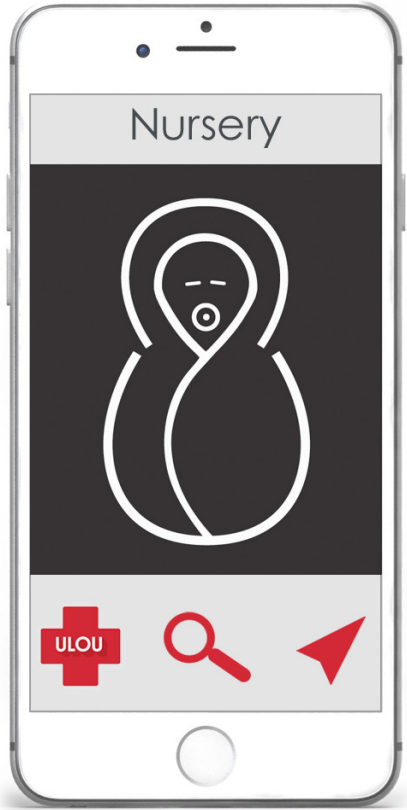
linked to Wifi can often be unpredictable inside large buildings and in the event of an emergency, it is critical that the app be reliable, accurate and provide instant feedback.

To create a more inclusive environment, a self-help kiosk with tablets running the app can be signed out to individuals who do not have access to a mobile media device. The mobile app will be available in 27 different languages and will use voice recognition software to help individuals who are hearing impaired.

The mobile application will automatically collect the following data:

- Language of choice selected
- Destinations by frequency
- Top search items
- The total time it takes the visitor to arrive at their intended destination
- Program errors

This data will then be used to help improve the ULOU wayfinding system and respond to increased demands.



CLOSING

In the past, when a public information icon was deemed to have achieved a universal understanding, it became very difficult to change, modify or adapt these icons. The perception was that the time and effort required to attain exposure on a mass scale was invaluable and superseded considerations for new iterations.

However, as technology continues to evolve, it is providing us with new and exciting ways of connecting to one another and the world around us. Open-source projects that encourage shared ideas and feedback, leverage the power of their communities to help gain exposure and engage with people around the world. Attaining universal understanding means something completely different today.

In 2014, Canada welcomed over 260,000 new immigrants to the country (Government of Canada, 2015). As cities become more diverse, there is growing need to address the communication needs these diverse communities require. With the introduction of new legislature such as the *Accessibility for Ontarians with Disabilities Act*, it is now becoming a requirement for public sector organizations to make public information accessible.

The research conducted in this project indicates that when designed correctly, icons have the ability to be more inclusive and more effective than written signage. The 'model of understanding' created in this work is intended to provide designers with a basic framework when designing icons where the aim is to attain universal understanding. Looking through an inclusive lens, the goal of the 'model' is to view accessibility as an integral part of the design cycle and to improve comprehension rates for all individuals.

In order to ensure the highest comprehension rate for an icon, it is crucial that designers test icons to understand what the most apt representation is. Designers need to invest time in research to understand how people define a specific referent. Testing and evaluation should be woven into the design process. Analyzing the feedback from participants about what worked and what failed helps to inform the design process. It is much easier to narrow the focus once you understand what does not work.

Inclusive design emphasizes that the diverse needs of people should continually inform the design process and the design process should continually evolve.



BIBLIOGRAPHY

- Abdullah, R., & Hübner, R. (2006). *Pictograms, icons & signs: A guide to information graphics*. London, UK: Thames & Hudson.
- Adams, L. S. (2011). *Art Across Time* (4th ed.). New York, NY:Mc-Graw Hill.
- Baldwin, M. (2014) *Participatory Action Reserach*. In M.Grey,J. Midgley, & S. Web (Eds.),*The SAGE Handbook of Social Work* (pp. 467-481). London, UK: Sage.
- Baxter, P., & Jack, S. (2008). *Qualitative case study methodology: Study design and implementation for novice researchers*. *The Qualitative Report*, 13(4), 544-559. Retrieved from <http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf>
- Bradbury, H., & Reason, P. (2008). *The SAGE handbook of action research: Participative inquiry and practice*. Los Angeles, CA: Sage.
- Collins, B.L. (1982). *The development and evaluation of effective symbol signs*. Washington,DC: U.S. Department of Commerce.
- Cowgill, J., & Bolek, J. (2003). *Symbol usage in health care settings for people with limited English proficiency: Evaluation of use of symbol graphics in medical settings*. Scottsdale, AZ: JRC Design. Retrieved from <http://www.hablamosjuntos.org/signage/pdf/pt1evaluation.pdf>
- Dewar, R.E. & Ells, J.G. (1974). *Comparison of three methods for evaluating traffic signs*. *Transportation Research Record*, 503, 38-47.
- Dreyfuss, H. (1972). *Symbol sourcebook: An authoritative guide to international graphic symbols*. New York,NY: McGraw-Hill.
- Edworthy, J., & Adams, A. (1996). *Warning design: A research prospective*. London,UK: Taylor and Francis.
- Forrester CSO Insights. (2012). Retrieved March 21, 2016, from <https://www.csoinsights.com/about-us>
- Government of Canada. (2015). *Facts and figures 2014 – Immigration overview*. Retrieved from <http://www.cic.gc.ca/english/resources/statistics/facts2014/permanent/01.asp>
- Guffey,E.(2015). *The Scandinavian roots of the International Symbol of Access*. *Design and Culture*, 7(3),357-376. doi:10.1080/17547075.2015.1105527
- Horton, W. K. (1994). *The icon book: Visual symbols for computer systems and documentation*. New York, NY: J. Wiley.
- Lazarte, M. (2003, November 29). *Wheelchair ride for guerrilla art*. Retrieved March 24, 2016, from http://www.iso.org/iso/home/news_index/news_archive/news.htm?refid=Ref1803

- Lidwell, W., Holden, K., & Butler, J. (2003). *Universal principles of design: 100 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design*. Gloucester, MA: Rockport.
- Mangan, J. (1978). *Cultural conventions of pictorial representation: Iconic literacy and education*. *Educational Communication and Technology*, 26(3), 245-267.
- Modley, R., & Myers, W.R. (1976). *Handbook of pictorial symbols: 3,250 examples from international sources*(p. 5). New York, NY: Dover Publications.
- Ogilvie, M., & Boyle, T. (2012, April 4). *Best and worst GTA hospitals: Toronto-area lags in patient care, national report says*. Retrieved December 12, 2015, from http://www.thestar.com/news/gta/2012/04/04/best_and_worst_gta_hospitals_toronto-area_lags_in_patient_care_national_report_says.html
- Ontario Government. (2016). *Accessibility rules for public sector organizations*. Retrieved March 20, 2016, from <https://www.ontario.ca/page/accessibility-rules-public-sector-organizations>
- Poovaiah, R. (n.d.). *Hospital symbols: A case study*. Retrieved from https://web.archive.org/web/20040312203947/http://www.idc.iitb.ac.in/ravi/signage/theory/casestudy/hospital/symbol_page1.html
- Rhodes, M. (2016). *Japan's Arcane Pictogram System Gets a Much-Needed Update*. Retrieved January 30, 2016, from <http://www.wired.com/2016/01/japans-arcane-pictogram-system-gets-a-much-needed-update/>
- Rogers, Y. (1989). *Icon design for the user interface*. In D.J. Osborne (Ed.), *International Reviews of Ergonomics* (Vol. 2, pp. 129-154). New York, NY: Taylor and Francis.
- Ryan, C. (2013). *Language Use in the United States: 2011*. Retrieved from <https://www.census.gov/prod/2013pubs/acs-22.pdf>
- Sternberg, R. J. (2003). *Cognitive theory* (3rd ed.). Belmont, CA: Thomson Wadsworth.
- U.S. Department of Transportation. (2004). *In-vehicle display icons and other information elements: Volume 1: Guidelines* (Publication No. FHWA-RD-03-065). Turner-Fairbank Highway Research Center, McLean, VA. Retrieved from <http://www.fhwa.dot.gov/publications/research/safety/03065/03065.pdf>
- Woodyard, C. (Aug 03, 2010). "One third of drivers can't recognize this idiot light." USA Today.
- Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage.
- Zender, M., & Cassedy, A. (2014). *(Mis)understanding: Icon comprehension in different cultural contexts*. *Visible Language*, 48(1), 69-95. Retrieved from <http://ezproxy-library.ocad.ca/login?url=http://search.proquest.com/docview/1547940110?accountid=12991>
- Zwaga, H. J., & Boersema, T. (1983). *Evaluation of a set of graphic icons*. *Applied Ergonomics*, 14(1), 43-54.