Metaphorical Connections to Interfaces

Guidance for Picking Icons Through a Contextual Approach

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Abstract

This paper explores the implications of metaphorical elements in the context of physical products that coexist with a digital interface, through an empiric and theoretical approach. Further, problematic aspects of the use of metaphors in a digital space will be discussed, and two prototypes will be created to investigate how icons are perceived in different contexts.

In cooperation with home-security company Verisure, the prototypes will be produced and usability tested. Fundamental interaction design principles will be implemented in order to investigate the impact of metaphor in icon-based interaction. These findings will be discussed and processed into a set of key factors to consider when working with icons.

Keywords: Metaphor, Contextual Design, Icon Design, Skeuomorphism, RITE.
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1 Introduction

1.1 Background

The use of metaphors in interfaces is a highly discussed issue in the field of interaction design, as they provide us with the means to understand our complex digital devices. Metaphors are used to make sense of the world, and the digital products we create and use. Even if we designed an interface without any obvious metaphors, the user would create their own metaphors to the presented symbols, as it is a part of our cognitive processing (Saffer 2005:21).

However, there are different believes whether the designer should provide the metaphors, or if it should be up to the user to create their own associations. Arguments have been raised that since the designer is acquainted with the product, they should also be able to design the best possible metaphors for it (Saffer 2005). While others argue that metaphors alone are not enough for effective design, and to truly maximize ease of use, we need to go beyond metaphors (Mohnkern 1997, Cooper et al. 2012).

The area we have chosen to highlight is how icons can communicate functionality in a home security based application geared towards a Scandinavian market. How context and other external factors can have an impact and where metaphors play an important role for users to relate to and understand what is being presented.

To conduct research on this subject we approached the company Verisure, who provides services in the area of home-security alarm systems, climate and energy analyzing. Today they have 1.6 million customers in 13 countries that are connected to their system.

Their objective is to set new standards for the smart home, with a wide variety of sensory-products connected to their alarm system. The selection contains smoke detectors that analyze temperatures and humidity, smart-plugs to control energy consumptions, and lock-modules to control access to the house; all connected to the smartphone.
In addition, customers have a different amount of devices connected to their alarm systems, which adds another layer of complexity in picking coherent and understandable icons to represent different actions and behaviors of the system.

1.2 Purpose and Problem Definition

The purpose of this paper is to research the use of icons in modern service-based applications, through the use of Interaction Design principles. Our goal is to provide an increased sense of understanding and trust to the users of Verisure's home-security systems. By comparing data gathered from a non-contextual prototype and one contextual, we will attempt to answer the problem definition:

"How can we design icons to reduce the risk of their perceived functionality being misinterpreted by new users of icon-based interaction?"

2 Theory

2.1 Metaphor

In this chapter we will present metaphor and its use throughout history, as well as more contemporary research and usage of it.

2.1.1 Brief History of Metaphor

Before the introduction of the Xerox Star and the breakthrough Graphical User Interface (GUI) in the early 80's, metaphor was largely considered a part of literature and linguistics. It is commonly considered a way to help the reader understand one thing, by describing it as if it was something else. Lakoff and Johnson wrote that "The essence of metaphor is understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson 2008:24). Metaphor is considered a good way to help us understand abstract concepts such as time by thinking of it as "moving forward" and us "putting the past behind us" (Saffer 2005:6, Blackwell 2006:494).
But with the entry of the GUI and the creation of the desktop metaphor ("the computer is a desktop") by Xerox (see fig. 1), shortly followed by Apple and Microsoft, metaphor came to play a big role in the design of operating systems and applications for decades to follow. Often described as one of the holy grails of User Interface design (Erickson 1990:65, Blackwell 2006:490).

![MS-DOS, a User Interface before the breakthrough of the GUI (left) and Xerox Altos desktop metaphor GUI (right).](image)

The word metaphor derives from the greek word *metaphora*, which basically means "to transfer" or "carrying across" (Oxford English Dictionary). This is exactly what it is meant to do in GUI's, as Saffer puts it; "we do not speak machine language", the metaphors role is to make the computer understand us and make us understand the computer (Saffer 2005:3). For example physical objects have inherited values that are not present in digital ones. Displays do not indicate that you should tap in a specific place without first creating a metaphor for something physical like an icon that indicates that you can tap it. This makes the metaphor transfer the physical objects functionality to the digital, and helps us understand it (Mohnkern 1997:11, Gaver 1995:271).

Ken Mohnkern suggests that the power of metaphor in literature and linguistics lies in the comparison between two very different things, where the pairing seems unlikely at first and the similarities are not obvious. In interface design however he argues that since one of the things is unknown, the power lies in making this new and unknown interface look and act like a
previously known one (Mohnkern 1997:11). An example is how Apples iPhoto uses a photo album metaphor (see fig. 2) to present the images stored on the hard drive of their devices (Apple 2013). This allows people to use prior knowledge in order to understand and navigate new and unfamiliar processes and situations (Madsen 1994:60).

![Fig. 2: Apples iPhoto using a photo album metaphor for displaying images stored on the hard drive.](image)

### 2.1.2 Views on Metaphor

Creating familiarity in unfamiliar environments can help to reduce stress, confusion and anxiety while increasing self-assurance and engagement (Marcus 1998:48). This is, according to Saffer, one of the top reasons that the desktop metaphor achieved such acclaim and has managed to live on for more than three decades. By using several metaphors linked to desktops and offices, people were able to apply their prior knowledge to understand the new medium (Saffer 2005:17). Another reason is that the metaphor had the possibility to scale, meaning that desktops, folders and papers could contain a lot of varied tasks of different complexity (Saffer 2005:24).

By aiming the early personal computers at office workers, the metaphors of files and folders stored in file cabinets became clear and understandable (Marcus 1998:48). However, when the comparison is not clear, and the user does not possess enough prior knowledge about the metaphor, the effect
might be the opposite, making his or her performance worse (Blackwell 2006:499). Saffer mentions this in his "Guidelines for Metaphor Usage" by classifying metaphors as contextual and therefore must be geared towards the specific context in which they will be used when you are developing them (Saffer 2005:23).

Many people were perfectly capable of understanding and using computers long before the GUI was introduced, which created problems with the use of the desktop metaphor upon introduction (Blackwell 2006:495). In a report by Carroll and Mazur where they performed user test on the Apple Lisa, another early computer using a desktop GUI, they noted that most of the users found the metaphor both confusing and in some cases frustrating (Carroll & Mazur 1985). Similar concerns were expressed by Halasz and Moran about making the metaphor of the storage structure of the computer being like file cabinets in an office. Since metaphors are contextual and all people who use computers do not work in offices they argued that the differences would confuse users more than it would help them. They also saw functionality in the computer that was not present or possible in a file cabinet and therefore not conveyed by the metaphor (Halasz & Moran 1982:384).

When Lakoff and Johnson were researching the use of metaphor in linguistics and literature they pointed out that metaphor does not just highlight similarities between two things, but by comparing them to each other through metaphor you also hide the differences between the two (Lakoff & Johnson 2008:36). Metaphors therefore need to be chosen carefully so they do not ruin or distort key features since the target mostly will not act exactly like the subject of the metaphor (Saffer 2005:17-24).

The importance of this became apparent in Croner & Wessman’s user tests of metaphorical applications on Apples iPad. The participants felt frustration and a decrease in motivation when the calendar application (see fig. 3) lacked functionality present in a physical calendar (Croner & Wessman 2013:25). The unknown digital object simply could not match the functionality of the physical one, something that might lead to people using the ab-
stract digital object incorrectly since the metaphor implies that it would work as the physical one (Saffer 2005:19).

Fig. 3: Calendar application on Apple's iPad, made to look and feel like a real life calendar.

Another example is the choice to use a postal metaphor for sending messages over the internet, what we know as email. By using this particular metaphor through envelope icons and terms like inbox, users tend to think of it as a sealed message that goes from one person to another just like regular mail would. However, this is not the case, as the laws protecting digital mail are not the same as the ones protecting traditional physical mail. The metaphor implies functionality in the form of privacy that is not present in the service (Mohnkern 1997:12).

In addition to lacking some of the previously known objects functionality, the problems of metaphors hiding differences also becomes apparent in the opposite direction. The abstract digital object usually packs more functionality than the concrete physical object does (Cooper 1995:128). The usage of metaphor effectively makes the user unaware of the possibilities that are not present or possible in the metaphors physical object. For example the file cabinet metaphor cannot explain shortcuts, password-protecting files or undoing the deleting of a document, things that are possible in its digital representation (Saffer 2005:19, Halasz & Moran 1982:384).
2.1.3 Skeuomorphism

In the field of archaeology, skeuomorphism has been a subject studied for a long time. Basalla defined it as an element of design that was essential to an artifact before, and although it serves little to no purpose for it anymore, still is present. An example is the ancient Greeks replicating their wooden buildings in stone. The wooden roof joists sticking out underneath the roof, with the initial function to hold the roof up, were replicated with evenly spaced stone cubes sticking out under the roof (see fig. 4), serving no other purpose than being decorative and making the buildings look familiar (Basalla 1988:107, Coyne 1992:7).

![Fig. 4: Stone cubes sticking out of the wall but not serving the same purpose as their wooden predecessors.](image)

Derboven et al. defines skeuomorphic interfaces in the context of HCI as UIs mimicking real-world objects with high fidelity, to communicate meaning and functionality to the users. For instance, the first generation of iPad applications were rich of their definition of skeuomorphism. Apple's iBooks is using shadows, textures and layering to replicate the look of an actual book (see fig. 5), and Propellerheads Reason tries to mimic how physical music production looks (see fig. 6), even though they are represented in a digital space (Derboven et. al. 2012:716).
In this study we are going to use Derboven et al. definition of skeuomorphism. There is however a debate that is currently going on whether or not skeuomorphism is the correct term to use to describe these kinds of user interfaces. O’Hara argues that based on Basalla’s definition the word skeuomorphic can only be used to describe objects or artifacts that survive from an original form, even though they are not required anymore (O’Hara 2012:281-283). This would mean that skeuomorphism cannot be designed into a new technology. Elements in a GUI can become skeuomorphs, but they cannot be created (The Economist Explains 2013, Baraniuk 2012).
There is a considerate process to determine if a product should include skeuomorphic elements, as the physical material is loaded with different cultural values. Jung and Stolterman implies that the choice of material in digital products plays a significant role in terms of user experience (Jung & Stolterman, 2011:156). This is even more important when working with digital technology as it has been described as a material without any properties, meaning that the designer have the opportunity to step beyond all previous barriers and break new ground (Löwgern & Stolterman 2004).

2.1.4 Icon Design

Since their introduction in the Xerox Star, icons have become a universal part of just about every graphical user interface. Basically they are representations of objects, tools and actions presented in a compact form (Rogers et al 2011:169). In icon design metaphor has been a one of the most accepted and used methods since the 80's (Gittins 1986:519) and still remains today (Setlur et al. 2005:654).

The connection between the icon and its function can be presented in several ways, but according to Rogers et al the most common are, Similar representation, meaning the use of a picture of a file to represent the target file. Analogical representation, using a picture of a pair of scissors to represent cut, and finally Arbitrary representation, for example the use of an X to represent delete. The most effective of these are usually the ones that have a direct mapping between the representation and what it is representing (Rogers et al 2011:170).

2.1.5 Guidelines for Working With Metaphor

Gentner and Grudin describes an event taking place at IBM in the early 80's where recommendations were made to implement more analogies in text editors, to make them look and act similar to typewriters. The recommendations proved successful in attracting more users to the software. However functions far beyond the capabilities of a traditional typewrites were built into the text editor, leading to writing itself evolving, making the typewriter obsolete (Gentner & Grudin 1996:31). This is an example of metaphors de-
grading over time to eventually die completely. "The computer is a desktop" has been a metaphor for computers since the breakthrough of the GUI, but does it serve any purpose anymore? Do people still think of the computer as a physical desktop? (Saffer 2005:20).

Alan Cooper argues that this is the biggest problem with the usage of metaphor:

"Metaphors offer a tiny boost in learnability to first time users at tremendous cost. The biggest problem is that by representing old technology, metaphors firmly nail our conceptual feet to the ground, forever limiting the power of our software" - (Cooper 1995:127).

Marcus expresses the same worries saying that metaphors will change along with development in technology and culture. When this happens the users risk to not understand or appreciate the metaphors anymore (Marcus 1998:49).

Despite the criticism the potential of metaphor has stayed apparent over the past three decades. Halasz and Moran claims the reason behind this is because all new learning and understanding is built on previous knowledge. Therefore they suggest that metaphor should play role in teaching novice users about unknown and abstract systems, but should be avoided for detailed reasoning (Halasz & Moran 1982:385-386). Saffer adds that metaphor should not be the concept, but only support it. The metaphor should be fitted to the functionality and not the other way around (Saffer 2005:23).

When Microsoft were researching new user interfaces for their Surface platform, they imagined it as a world of its own, with characteristics and rules that the user had to learn to be able to operate in. In order to make this understandable they decided to experiment with metaphor in all stages of the design process as a way to avoid replicating familiar design patterns yet create an interface that was understandable and predictable (Hofmeester & Wixton 2010).
By generating a lot of metaphors during brainstorm sessions where the participants got to sketch their ideas on napkins and then grouping them together based on similarities, a large number of metaphors were created, and later evaluated and tested. These gave the project direction and in combination with user tests they provided the team with understanding of where to compromise with metaphor. In their findings they argue that logically users need to understand metaphors in order to realize many of their benefits, but practically they only need to appreciate the metaphor in order to adopt a new system (Hofmeester & Wixton 2010).

However, because of the limitations of metaphors, searching for a suitable one this way could be time consuming and in the end pointless. Cooper compares searching for the perfect metaphor to:

"searching for the correct steam engine to power your airplane, or searching for a good dinosaur on which to ride to work" - (Cooper 1995:127).

Lastly Cooper suggests to use what he defines as "idioms" in metaphors place when designing. He describes them as figures of speech that are easily understood and remembered, but not in the same way that metaphors are. Examples of these are something being cool or someone being in a pickle. There is no analogy to understand and you have to learn their meaning, but once learned they are easy to understand and remember (see fig. 7). Examples of idioms in graphical user interfaces are scrollbars and radio buttons. Even Microsofts flying window logotype or the five rings of the olympic are, according to Cooper, easily recognized non-metaphoric idioms full of meaning and values (Cooper 1995:128).

Fig. 7: The warning sign with an exclamation mark and hazard symbol are examples of idioms according to Coopers definition.
2.2 Interaction Design Concept Fundamentals

To serve as a boilerplate for our design process, there are several implementations of basic interaction design principles that will be incorporated into our work.

2.2.1 Affordance

The term affordance originates from psychology, where James J. Gibson defines it as relationships between an object and the person that interacts with it. These relationships are present even if they are not known or visible (Gibson 1977).

In 1988, Donald Norman reappointed the concept into a Human Computer Interaction context, and it has since then gone through several iterations and refinements, which has caused a great confusion among designers. In one of Norman’s later papers on the subject, he clarifies his definition of affordance by separating it into two different categories, “perceived affordance” and “real affordance” (Norman 1999).

Norman argues that there is an important difference between the two mentioned terms, as they are independent design concepts. When a digital service is being designed, it is mainly perceived affordance that can be added to it by giving visual cues, such as outlining a shadow around a button (see fig. 8), adding icons or using a bordering color to imply that it is clickable (Norman 1999, Weinschenk 2011:16).

Real affordance cannot be “added”, as it is most of the times already constrained by the physical product or system, e.g. the physical screen size will not change if you click a button, hence it is rarely of interest for interface designers (Norman 1999).

When affordance is mentioned in the context of designing digital services and interfaces, we mean perceived affordance, which essentially is a form of learned conventions, and does also have a close relationship with constraints and feedback, which will be defined in the following sections (Rogers et al. 2011, Norman 1999).
Fig. 8: The label under the OS X heading does not look clickable, but when pressed it is working as a button to switch which information is shown. This functionality is easily overlooked due to lack of perceived affordance.

2.2.2 Constraints and Conventions

There are several different types of constraints, one of which is cultural constraints, which Norman refers to as conventions. Conventions are learned behaviors; it is how we know how to scroll, and how western cultures assumes that left is backward and right is forward in the context of web browsers. As conventions develop over time through practice and appearance, the designer needs to respect them, and be aware of the risks of challenging them without consideration (Norman 1999, Saffer 2009:19).

Logical constraints are closely related to cultural, except they may not be shared among cultural groups. They rely on the users reasoning to know when a specific task is finished, whereas physical constraints could be used to restrict a specific action, making it impossible to complete, or in contrast, enforce it (Norman 1999).

2.2.3 Feedback

As affordance plays the role to guide for intended interaction, feedback is the answer to it. To receive information whether you have finished a task or not, and allowing the user to continue with the activity, it is a matter of feedback. It can be visual, auditive, verbal or tactile, or a combination of these, which should be picked wisely. The weight of designing appropriate
feedback cannot be overstated, because without any indication to the user’s actions it will lead to confusion and frustration (Rogers et al. 2011, p.21).

2.2.4 Models

“The most important design tool is that of coherence and understandability, which comes through an explicit, perceivable conceptual model.” - (Norman 1999:41).

In order to create a pleasant user experience, understanding how different models work and how they are applied is essential (see fig. 9). The implementation model contains a wide range of features and backend capabilities that if not presented in the right way will create miscommunication with the user’s mental model (Cooper et al. 2012).

![Fig. 9: A representation of the implementation model, versus the mental model.](image)

The mental model represent the vision a user has about the service or product he or she interacts with, whereas the conceptual model is the actual model that is given to the user, it is the model they will interact with (Weinschenk, 2011:32). People are likely to use some sort of metaphor to conceive a mental model, and if none is provided it will likely lead to difficulties handling the product, especially in a digital space (Shneiderman 1983).

Users do not need to know how complex a product or service is to use it, they create cognitive shorthand’s to explain it. Alan Cooper gives the example of how peoples mental model is towards electricity, as they imagine it flowing like water through the wall when they plug appliances into power...
outlets. Even though it does not resemble what actually is happening, it still simplifies a complex mechanic, and creates a sense of understanding (Cooper et al. 2012:66).

To enable users to successfully navigate through digital environments, the conceptual model should contain properties of the physical world, to let them apply the knowledge of how physical objects works when they interact with virtual environments (Roger et al. 2011:47). This does however only apply to a certain extent, since metaphorical connection is not the key component of the conceptual model. For instance, spread sheets are not intended to imitate accounting sheets, but rather let people use their recognition instead of memorizing tasks (De Young et al. 1999).

A successful conceptual model is one that is as closely placed to the mental model of the users as possible, and to help this process, the concepts of affordance and feedback are especially important (Weinschenk 2011:87, Saffer 2009:133).

3 Methods

In order to gather in-depth data through our prototypes, we have chosen to exclusively work with qualitative methods, since they tend to be more likely to answer important questions about what, how and why people make the decision they commit to (Cooper et al. 2012:88). As qualitative methods relies on understanding users and their behavior, the risk of failure and biased data is lower than using a quantitative approach, and you do not need a perfect study to get decent results (Nielsen 2004).

3.1 Brainstorming

As a method of idea generation, brainstorming is a tool to let all the concepts get out of our heads and record them for later by the use of pen and paper (Saffer 2009, Cooper et al. 2012).

When a brainstorm session is being conducted criticism is discouraged, as it is more likely that original ideas will be expressed if you do not have to wor-
ry about negative evaluations. This should lead into a quantity of ideas, which can later be refined into quality content, as even the most foolish concepts may have qualities that can be turned into valuable insights later on (Wang et al. 2009, Rogers et al. 2011:373).

Brainstorming is an iterative process that includes two major stages that will influence the final product; the first stage is idea exchange, which is the social process of sharing thoughts and concepts. Secondly, the existing ideas are evaluated and built upon; this is the idea expansion phase, which is worked out based on reasoning and discussion (Wang et al. 2010).

An inspirational environment that contains relevant work, research and models related to the research is vital for a successful brainstorm, as it may generate connections that have not been thought of before (Saffer 2009).

A positive side effect of brainstorming is that you switch your brain into "solution mode", because it requires a different mindset to come up with design concepts in contrast to performing analytic research (Cooper et al. 2012:155).

3.2 Prototyping

"One of the founding principles of UX design is to fail first and to fail early" - (Allen & Chudley 2012:414).

Prototyping is where the designer takes all their knowledge and experience into account to create a holistic representation of their conceptual model. This representation should allow stakeholders to interact and explore the prototypes suitability for the particular problem being tested. Therefore it is common for a prototype to emphasize one or a few qualities while filtering away the rest (Saffer 2009:174).

According to Rogers et al. it is often said that the users do not know what they want, but the beauty of prototyping is that if you put something in front of them and let them use it they will soon be able to tell you the things that they do not want (Rogers et al 2011:390).
Lim, Stolterman and Tenenberg defines prototyping as the activity of making and using representations and manifestations of design ideas. The goal is to find the simplest way possible to present the qualities that the designer is interested in researching while de-emphasizing the rest. This must happen without distorting the users understanding of the bigger picture (Lim et al. 2008:4).

Prototypes can be done in several ways and with different amounts of detail to test different aspects. Commonly they are classified as either low fidelity or high fidelity, where low fidelity prototypes usually are used to evaluate an ideas functionality and product flow. They can be made from very simple materials like paper or cardboard. They can also be digital but with very limited functionality, and a basic interface. Low fidelity prototypes are usually crude and unpolished (Saffer 2009:177).

These kinds of prototypes tend to be quick and cheap to produce, and that also means that they are quick and cheap to iterate in order to explore different design solutions and ideas (Rogers et al. 2011:392). This has a huge value in a design process as it offers a fast and easy way to save time and money by testing ideas in a very early stage.

Lim et al. argues that the best prototypes are the ones that make the possibilities and limitations of a design idea visible and measurable in the simplest most effective way possible (Lim et al. 2008). Paper prototypes, where the designer creates a walk through the system by representing different states and screens on paper are a great way of getting this kind of input, as they are the fastest and cheapest to create (Saffer 2009:177).

It is important to note that low fidelity prototypes are only meant to be used for exploration and never get integrated into the final product (Rogers et al. 2011:392). They are created to get put together quickly to test a concept and then get thrown away just as fast (Saffer 2009:177).

High fidelity prototypes on the other hand are better for exploring things like the look and feel of a product. Unlike low fidelity prototypes they work mostly as they should and contain as many details as possible in both the
interaction of the product, the industrial design, the engineering and the visual design. When the prototype looks like a real product the designer will receive a higher accuracy on the feedback. This is especially important for complex functionality in the finished product as it is hard for a user to imagine it without actually experiencing it (Saffer 2009:180).

Prototypes will, however, always be limited in their functionality, and as a result the questions they can answer will also be limited. Because of this, prototypes should be built with a clear idea and goal about what question it should be able to answer (Lim et al. 2012, Rogers et al. 2011: 396).

The designers evaluate the prototypes to find the ideas that work and the ones that does not. Working in this case means that they should work for both the designers, the clients and for the users. Therefore it is recommended to create multiple variations of these prototypes that can be played with and tested by all of the three. This is to support the designer in choosing between different approaches to the problems. Often there is a clear preferred prototype among the testers, but Saffer says that there exists several cases when all of the prototypes work well. Then the biggest challenge is to shape the best parts of each prototype into a new hybrid (Saffer 2009:177).

Based on the limited time-frame we have decided to work with the Rapid Iterative Test and Evaluation Method (RITE). It focuses on traditional means of prototyping and usability testing, but emphasizes making changes as soon as a problem is identified and rapidly evaluating these changes. For example if a problem has been identified after a user test that has an obvious cause or solution, like changing the label on a button or rewording a dialog box, solutions can be implemented prior to the next participant (Medlock et al. 2002:2). This method has also been proven to be a good fit when working with metaphor in previous studies by Microsoft (Hofmeester & Wixton 2010).
3.3 Usability Testing

Usability testing is the phase where you invite participants representing real users and give them simple tasks to carry out. Meanwhile, the designer should observe and record their performance, thoughts and attitude towards the product (Gould & Lewis 1985:302). The information collected is then to be analyzed, problems diagnosed and recommendations of changes presented (Dumas & Redish 1999:22). When the problems have been specified they must be fixed, this means that the design process must be iterative and consist of a cycle of tests and redesigns repeated as often as necessary (Gould & Lewis 1985:300, Saffer 2009:184).

When performing user tests the goal of the designer is to highlight usability issues of the product. This is why it is important to test early on, and continuing to test through the entire design process (Dumas & Redish 1999:22).

It is important not to identify yourself as the designer during user tests to ensure that you get the maximum amount of feedback from the user. The reasoning behind this is that it might make the user change their feedback or make it seem less problematic than it actually is if they know you built it (Saffer 2009:183). In addition the subject will feel more comfortable with leaving feedback in its own environment, that means on the users home, office or in the users home town (Saffer 2009:181). The exception is if the prototype being tested requires a specific setup or is strongly connected to a specific place, as the setting might influence the tests outcome (Gray & Salzman 1998:212).

One of the most common ways of testing usability is the "Think aloud" mindset. It is performed by having a user loudly explain his or her actions and feelings towards the product while using it. This way it is easy for the designer to understand the user and the problems or misconceptions that are found (Holzinger 2005:73). In combination with "Heuristic evaluation", where you let usability experts evaluate the prototype, you have a solid foundation of highlighting usability issues (Nielsen & Landauer 1993:206, Rogers et al 2011:506).
Nielsen et al. performed several experiments with the heuristic evaluation method where they used computer science students as experts to find out how many usability problems that they would be able to find in a product with well known usability issues. Their findings revealed that three to five users will be able to find most of the big issues. Ten or more experts have a very small chance of finding new problems (Nielsen & Molich 1990:255, Nielsen & Landauer 1993:209).

The same experiments were repeated by Virzi with the same results, only this time with users that were not experts, in fact they were chosen because they had little or no computer experience at all. All of his studies reported that approximately 80% of the usability problems would have been found with only five testers. It was also reported that the important problems have a much higher chance of being found than the less important ones (Virzi 1992).

This method has several advantages, it is cheap, easy to motivate people to do, it does not require any planning in advance and it can can be used early on in the development process, making it suitable for testing prototypes (Nielsen & Molich 1990:255).

4 Design Process

4.1 First Prototype

To start collecting data in order to highlight usability issues we were given a batch of icons by our partner Verisure from their current homepage and application. Some relying heavily on analogy and metaphor to illustrate their functionality, like a funnel to represent filtering of what information to see. Others using solely arbitrary design, like a triangle with an exclamation mark to represent warnings or a plus to show that something is expandable (see fig. 10).
The first thing we wanted to test was how clear the connection between the icons and their functionality was without any context. To come up with a prototype to effectively test this we had a series of brainstorm sessions inspired by Wang et al. where we, as designers, sketched all of our ideas on paper, in an idea exchange phase (Wang et al. 2010). The work environment was surrounded by mockups and wireframes to support our creative process, as suggested by Saffer (Saffer 2009). By avoiding criticism in the early stages several ideas were raised on how to explore peoples interpretation of icons (Rogers et al. 2011, Wang et al. 2010).

After getting our ideas on paper we developed them in an idea expansion phase by combining and concretizing them (Wang et al. 2010). At this stage a prototype began to take form, with the focus being as easy to build and modify as possible. The reasoning behind this was to be able to iterate it between single user tests (Dumas & Reddish 1999), while not being hesitant to throw it away once it had served its purpose (Saffer 2009).

In order to create a valid batch of icons to test against Verisure’s, we also researched well-known metaphors and idioms for the specific functionality we were investigating. For instance, Facebook uses a globe to represent notifications, whereas Spotify uses a megaphone and Twitter a bell.

As a byproduct of our brainstorming we also created something looking like trees (see fig. 11) to explore new connections, where the trunk consisted of the functionality we wanted to illustrate with our icon. From this we made branches of different things we felt was related to the functionality, increasing in abstraction-level the further away from the trunk you got. From the words on these branches new connections were created and suiting icons found.

Fig. 10: Examples of the icons used in our first prototype.
These were used to set up a test that highly emphasizes on a discussion with the user about what each symbol means and resembles to them. By giving him or her a statement and presenting a set of icons underneath to illustrate that statement (see fig. 12) we aimed to let the testers think loudly about each of the symbols relation to the functionality. Finally they were to settle on one choice that they felt had the clearest connection and then proceed to the next statement and a new set of icons to repeat the process.

By making the icons stand on their own without any context other than their functionality, we were able to test them on people that did not necessarily have any previous experience of Verisures products, or any of the other places where we gathered the icons from.

The prototype was built using HyperText Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript (JS) which are the most commonly used web standards (World Wide Web Consortium). The reasoning behind
this was that we both felt comfortable with writing code in these languages, and rapidly iterating it on the field. Another reason was that the icons were to be used digitally in a finished product and were already available in digital form. This would make a digital prototype the most time and cost effective way to answer our questions, which according to Lim et al. is the correct way of doing it (Lim at al. 2008).

Making a digital prototype would also help with implementing other important aspects of interacting with icons such as feedback in the form of changes of color when a user is hovering it. This is something that would be hard to implement in a paper prototype without interrupting the dialogue with the tester. Lastly using a digital prototype eased the documentation process by letting us record both the user and the screen at the same time and allowing us to focus on the user.

4.1.1 Testing of First Prototype

The first round of user tests were performed with students at the institution for Arts, Culture and Communication at Malmö University, the reasoning behind this was that it was available in an early stage of our design process and would give us a chance to test the RITE method out in the field without feeling pressure of wasting the time of the testers, and evaluate how good of a fit it was with our research.

Four users were picked randomly, however we tried to get diversity in gender and age when picking them. Three males and one female ranging in ages between 21 and 39 each got to sit down in front of our prototype for about 15 minutes. They were given a short introduction of who we were, what we wanted to research and how the test would be conducted.

We chose to emphasize the fact that neither of these icons were our work and that we simply wanted their opinion, as well as that there were no right answers to the questions that we were about to ask. This was to follow Saffer’s recommendations of not being there in the role of designer, in order to make the user feel comfortable expressing their thoughts to get honest feedback (Saffer 2009).
After this they were introduced to the think aloud mindset, we asked them to describe what they saw on the screen and what values or meanings these things possessed. One of us took a role of trying to interact and be a part of the conversation by making the user elaborate their thoughts, while the other took a more passive role of observing the user and document his or her actions and attitude towards the prototype itself for later iterations. In addition to the notes taken, the tests were also recorded by a screen recording software capturing sound, video from the webcam and the screen itself.

After every test we sat down to discuss the points raised by the tester, things we noticed and points where the prototype seemed unclear or problematic. Solutions on how to address these issues were quickly created and then sorted into one of two piles. Either problems that could be addressed right away, for example adding more icons and changing the terminology, or things that would be addressed before the next session of user tests, like the creation of specific icons and adding additional functionality to the prototype. The easily addressed problems list was processed, the solutions implemented and prepared to be evaluated after the next user test.

4.1.2 Insights from First Prototype

With this prototype we tried to answer our questions on how people interprets commonly used methods of creating connection between icons and functionality, free from any form of context. In the beginning we used very few icons to illustrate every statement, but after evaluations we found out that presenting the user with more options got their imagination running, giving us more feedback.

We entered the tests with a mindset that the interesting thing was not really what the user thought, but why they thought it. By using the prototype more as a support in the dialogue with the user, the feedback became more focused on what the functionality itself meant to the user. This allowed us to find new connections between the functionality and representations of it that had been overlooked before. Because of the RITE method these ideas could be implemented quickly before the next test in order to spawn new trails of thought and gather more information from the next user.
The first statement that the testers were to choose an icon for was "news". It quickly became obvious to us that the testers already had a very set definition of what news was and how this should be represented digitally as every single one chose the newspaper icon without a lot of discussion.

Something we also noticed during the dialogue with the first tester and that continued throughout all of the test sessions was that users seemed to prefer icons that they had little to no previous relationship with, unless they felt a really clear connection with one particular icon e.g. the newspaper icon. This was particularly evident when talking about the functionality "notifications" as all the testers disregarded the examples taken from Facebook (globe) and Twitter (bell) although they recognized them and were active users of the services (see fig. 13). Instead every single tester went for the megaphone icon saying that it illustrated what a notification was to them, a short loud message. However none of the users connected it to Spotify or any other application, something that implies that they created this metaphor by themselves.

![Fig. 13: Icons used to illustrate notifications, with the globe inspired by Facebook, megaphone by Spotify and bell by Twitter.](image)

This behavior seemed to continue with testers looking to create context and connections when none were given. The megaphone was unique in the test as every tester created the same metaphor, something that did not happen with any other icon. Although, users continued to use personal associations to connect icons and their functionality.

One of the statements, "filter" seemed to open up for very individual interpretation. Our first tester created a box metaphor of him hiding things in a box that he would store in the basement. The things would still be there, and he would be able to bring them back if he wanted to, but they would not bother him anymore. The explanation behind this was that it was simply
the way he dealt with things that did not interest him, he stashed them away somewhere until he would need them again.

This metaphor was implemented after the first test, illustrated by a pictogram of a cardboard box and placed with the other icons (see fig. 14), only to be completely disregarded right away by the following tester. According to him it would obviously would illustrate archiving, a process that to him was completely different from filtering. He much preferred a funnel for illustrating what he referred to as narrowing down information, in the same way a funnel does with liquid.

![Fig. 14: Icons used to illustrate filtering of information, with the box second to the left and the funnel to the far right.](image)

Another tester created a metaphor very similar to the box, where storing things in it would represent the filtering of information. When the testers were not able to create a metaphor of their own they appeared to instead return to similar icons that they already use. One tester did not make any connection with either the funnel or the box, instead he compared the action of filtering information to the most similar action he uses, to hide layers in Adobe Photoshop, an action that is illustrated with an eye that signals if the layer is visible or hidden. Almost as if you could close your eyes to not see specific things but still be able to see everything else. Because of this connection he argued that an eye would be the most suitable icon.

Similar results were reached when the level of abstraction in the statements increased and their own associations seemed to become harder to make. The statement to be connected to the internet seemed to be hard to illustrate for all of the testers out of their own imagination, instead they all referred to how their own devices show it. Two of the testers were users of Mac OSX and argued for the use of Apples WiFi icon, while the other two
who mainly used Windows compared it to Microsofts network bars (see fig. 15).

Fig. 15: OSX WiFi icon to the far left, and Windows network bars next to it.

After our first prototype we wanted to further examine the insights that we gathered with a second prototype.

4.2 Second Prototype

With a series of brainstorming sessions with mentors and colleagues, we came to the conclusion to compare the implications of metaphorical connections to icons in a highly contextual environment, in contrast to the non-contextual tests we performed before. This would be achieved by designing a high fidelity interface that consisted of icons without any helping text, to really force the users to analyze their choices.

The context was set to be in a home-security alarm application, where the designed interface was supposed to control and show information about your home-alarm system, hence a higher fidelity felt required to create a trustworthy relationship between the user and the prototype.

In order to get strong first impressions and make the icons stand out we designed the interface for a mobile viewport where it is more likely for icons to have to stand on their own because of the smaller screen estate. The focus was put in a few qualities to create a simple and rewarding interaction flow with emphasize on functions that are needed to create a holistic feeling, which included a status panel with a way to active the alarm system, history, company related news, and user settings (see fig. 16).
Fig. 16: Two of the views from the first iteration of our second prototype.

During the first prototype we concluded that people associate the megaphone as a metaphor to notifications, an archiving box as filtering and newspaper to display news, we chose to see if these connections were the same in a contextual environment. Additionally idiomatically loaded icons in form of warning triangles were also used to further test our assumption that idiomatic icons will deliver a strong message, but not what type of message.

To further strengthen the context of the application we chose to brand the interface in a company style (i.e. logotypes, and a professional color-scheme), in combination with perceived affordances in fashion of the color-scheme on the icons to ease navigation. We also used a login process, letting the users log in to one of our accounts to emphasize on the feeling that they are using a personal and authentic application (see fig. 17).
The prototype was designed to let users constantly talk about their associations with the icons, and once they made up their mind what they thought would happen, let them confirm or contradict their assumptions by directing them to a new view. This would hopefully lead into a fruitful discussion of the reasoning behind their actions, and what outcome they expected from it.

We chose to implement elements of skeuomorphism according to Derboven et al.’s definition in form of a keypad that is a direct replica of the physical one used by Verisure today, which were put in contrast to a flat design (see fig. 18).
Our intention was to investigate if these kinds of metaphors would influence the users trust towards the application.

4.2.1 Testing of Second Prototype

The second phase of user tests where performed at Verisure’s office in Malmö. Five users from different backgrounds with different professions and age were hand picked and invited. This was done in order to get diversity amongst our test subjects, while still being relevant as users or customers of home-security solutions. The test subjects age ranged between 22 - 38 and consisted of three females and two males. Two of the testers worked in IT, two in economics and one in healthcare.

Each test started off with a ten minute presentation about the Verisure product line and some of their services. The products were shown in physical form for the tester to interact with them and get to know them. We also presented ourselves, our thesis and how the tests would be conducted. Once again we emphasized that we were not the designers of what would be presented and that there were no wrong answers, all in order to get a good dialogue.

The introduction was followed by a user test session which ranged from 40 to 60 minutes in a closed off conference room. The reasoning behind this was to make it easier for the users to get an insight into the Verisure mindset in order to increase the security context as well as minimizing the amount of external factors that could interfere with the tests.

To get a sense of how the icons fit into the broader aspect of people’s lives, and see what associations people have to the presented icons, we once again chose to test this under a qualitative approach to help us identify patterns and behaviors (Cooper et al. 2012:88). The think aloud mindset was once again used as our main way of getting feedback from the user as it worked well during the first round of testing. The results were documented with the same setup as well only
this time both of us took notes while still being part of the conversa-
tion in addition to recording the users face and voice, as well as the
screen.

The tests were spread out over several days, which gave us a chance
to perform larger iterations between the tests, and also allowed us to
try some of the ideas that were raised during the first round of user
testing. We still worked with the RITE method, meaning that we sat
down after every test session and discussed the points raised by the
test subject, as well as problems with the prototype itself, and how
these could be solved. Since we had more time than during the first
round we were able to address larger changes concerning the flow,
functionality or how to easier research the things we wanted. The
solutions were, in similar fashion to the first round, evaluated and
decided if they would be kept, discarded or go through another
round of iteration.

By giving the users small tasks to perform in the prototype we were
able to see how well the icons guided them and helped them to
achieve their goals. Before doing anything they were to describe
what they thought would happen and why.

After the users had guided themselves through the prototype, the
dialogue continued about general feelings that they had towards it,
including things that were unclear and ideas of improvement. They
were then presented with the prototype from our first round of user
tests and performed a test very similar to that one, only this time
aware of the context. This was done to get results that we could easi-
ly compare to the first round of tests.

4.3 Results & Analysis

In this section, we will analyze and compare results from the tests of the
second round of user tests as well as insights gained by implementing
skeuomorphic elements in a home security context.
4.3.1 Notification Icon

During the tests of our second prototype, we were presented with a problematic situation right away when the Megaphone metaphor (that had been the uniform choice of all the testers to illustrate notifications during the first prototype) appeared to have different perceived functionality in our new one.

When our first tester, a 35 year old economist, was asked to describe what he thought would happen if he were to tap on the megaphone icon, he suggested that it would take him to the control panel of the home alarm. He recognized the icon as a megaphone, something that he connected to sound, and the closest match to that in our home alarm context was the alarm signal. This connection was also made by another tester, a 23 year old student also in economics, although she raised the point that it could make sense as alerts or events, but not as notifications in this context.

One tester, a 29 year old entrepreneur in IT did however immediately define the icon as notifications, but noted that the notifications would have to be of a more serious character than the ones you see in other contexts. All three of the mentioned testers were presented with the bell icon as an alternative, and all three noted similar problems with this icon as with the megaphone. However, they seemed more positive towards the bell as two of them acknowledged the icon as something less powerful and dominant, this made us use the bell icon for the next test, and change the wording from "notifications" to "events" when discussing it.

This presented new insights when the following tester, a 22 year old studying healthcare, were to interact with it. She also made the connection that it had something with sound and alarms to do, but she interpreted it as an assault alarm that would put her in direct contact with the police, as she found the usage of a bell in a security context as a way to call for attention. Moreover, the bell is already used in some of Verisure's products to illustrate their intrusion alarm something that seemed to cause confusion when presented with it. For the final test, the notifications page was reworked into more of a history or log of events and represented with a neutral icon in the
form of a document with a clock in its corner (see fig. 19). Our hopes were that this would illustrate a list that had something to do with time, and hopefully the user would fill in the rest.

![Form of a document with a clock in its corner.](image)

*Fig. 19: History log icon.*

This proved not to be the case in the following test, the 38 year old IT employee made a connection to a list of events and time, however, the conclusion made from this was that its functionality was entering own events like activating the alarm on specific times. This connection was not too surprising for us as we had discussed this when implementing it since the clock is a symbol that is very open for interpretation and a plain document is too.

When presented with the megaphone and bell icons as alternatives, the tester raised similar concerns as the previous testers, although he saw possibilities for them to be used in a home-security context as different levels of warnings and how serious they would be. He defined the megaphone as alerts, things that immediately call for attention, for example if the alarm went off in the house. The bell was still something important, but shaped more like a notification that he had asked for himself, like that his kids had gotten home and deactivated the alarm. He would be notified about it, but it would not call for his immediate attention. This seemed to be similar to previous tests where the bell was also classified as less serious than the megaphone.

### 4.3.2 Filtering Icon

After the results using a cardboard box metaphor for the action of filtering in the first prototype, it was implemented in the notifications view of our second prototype. This icon was well received by two of the testers. The 22 year old described the process of filtering in a very similar fashion as what was described during the first prototype. The 23 year old stated that the box
would mean to archive something, but claimed that the archiving and filtering functionality are similar enough to her that the metaphor works. The other three testers also defined the box icon to be an archiving action, but distinguished the act of archiving as a more permanent action than the act of filtering, meaning that it would take more effort to bring something back that is archived than something that has been filtered away.

When presented with alternative icons one of the testers stated that she started to like the box icon more and more, stating that it was easy to create an emotional connection to it, since everyone knows how to use a box, and everyone has done it at some point.

Two testers preferred a funnel icon instead, as they had been in contact with this icon before in spreadsheet applications like Microsoft Excel and had learned that the funnel means to filter information. These two testers had identified to view where the icon was present as an event log, giving them clues to what functionality they could expect to find inside. This made them argue that the funnel in combination with the context of the view should be enough hints of the icons functionality.

The funnel as a filter convention was not shared among other users, for instance one tester failed to recognize the icon as a funnel, instead she interpreted it as a flashlight or a wine glass, making it hard to connect it to a relevant functionality. Two testers identified the icon as a funnel but failed to see any relevant functionality linked to it. Once the functionality had been clarified by us, one of the testers disregarded it completely stating that funnels do not filter when used physically, you need something else for filtering e.g. a strainer or a coffee filter.

The users were also presented with the eye icon as an alternative, it was met with good reception from tester two and tester four as they felt like it could represent hiding certain information, an action similar to filtering. Tester three and five defined it to be something regarding surveillance, this could be interpreted in a number of different ways in a home-security context similar to the megaphone symbol.
4.3.3 News Icon

Another icon that caused confusion was the one representing the news-section, which from the insights from the first prototype suggested being a perfectly understandable representation of news in a digital format.

However, in the context of our application users proved that this was not the case, as our testers associated the icon to a wide range of functionalities. For instance, the first user guessed that it represented an event-log, similar to our notification panel. Whereas another user predicted that by clicking on it she would be taken to an instruction manual, where she could find information about how to install different devices in her alarm system.

Even in the tests where the icon was identified as news, it still caused confusion, as it was not clear to any of the users what type of news to expect, whether they would be from the company in the form of new products, a general view with updates from the system or a company blog.

4.3.4 Skeuomorphic Interfaces

The first three tests of our skeuomorphic keypad did not result in any direct connections to the physical keypad, making it hard to test if they felt an increased sense of security by it being skeuomorphic. When discussed points were raised that the digital replication did not look real enough in comparison with the physical product (see fig. 18, physical product and skeuomorphic representation).

As a result of the feedback we made a refined version for our last two tests, where we included the complete icon-set of the physical keypad to see if the results would be different, and while they succeeded in making the connection between the physical product and digital representation, neither found a more trustworthy relationship to a skeuomorphic keypad in contrast to a flat keypad (see fig. 18, flat design concept).

Our last tester did, however, point out that there is no harm to include skeuomorphic elements as long as it is done in a consistent manner. Meaning that keeping a visual coherency, in the form of colors and icons, which
are similar to the physical product. If this were done in a non-intrusive way, it would increase his sense of trust towards the application and the entire service.

He also suggested that this might not be applicable if the physical product-line has multiple variations of their products. If this were the case, it would be better to keep the application neutral to avoid inconsistency, something that could have the opposite effect on the user (Derboven et al. 2012, Marcus 1998).

5 Discussion

How to choose Icons

Metaphors used in the wrong context may give serious drawbacks as they can portray misleading functionality. Example given; the megaphone made perfect sense as notifications in a non-contextual environment. However, when set in a home-alarm context, it changes meaning to alerts and alarms.

The problem is that some users see the functionality of certain icons as obvious based on their prior experience. This might indicate that the icon is an accepted convention when it could be far from true, something that is supported by Halasz and Moran who in their research found that people will interpret things differently, and not being aware of this could confuse more than it helps (Halasz & Moran 1982).

In an environment full of people familiar with Microsoft Excel, the funnel icon would be clear evidence of this, as it has been used to portray the functionality of filtering for quite some time. However, the testers that were not familiar with the connection proved that the funnel is not an accepted convention. What makes it worse is that the metaphor of a funnel representing filtering failed to give these users any clue what the functionality of the icon was.
If the icon fails to illustrate its functionality, it risks having the opposite effect. Instead of representing an action in a compact form to help the user, you confuse him or her and might impact their entire mental model.

**Understanding Icons**

Something that became obvious during our user tests is that people want to find meaning where none is given, if an icon is unclear they will try to find suiting functionality for it based on its context. Something that Cooper refers to as cognitive shortcuts. If their guesses prove to be wrong the users risk feeling frustration and lack of motivation to continue (Cooper et al. 2012).

In similar fashion, our users had an easy time assigning new icons to functionality where they felt that the connection was unclear. During our tests of the filter functionality, ideas were raised to instead represent it by something other than a funnel. Strainers and coffee-filters where brought up as examples.

However, from iterating and evaluating our prototypes we feel that this will complicate the situation even further and confuse the users by adding another convention accepted only by a minority of the user-base. This is backed up by Coopers claim that trying to find that one magical metaphor is like "searching for a good dinosaur on which to ride to work" (Cooper 1995).

Blackwell also discusses this area and concludes that introducing a new metaphor creates confusion among the ones familiar with the previous (Blackwell 2006). The complete opposite of what it was meant to do from the beginning (Marcus 1998).

**Helping the User**

As mentioned in our literature study, icons can be empowered by the use of visual cues, animations and feedback, and if there is an uncertainty, helping text works as a fallback (Rogers et al. 2011, Norman 1997). For instance, any of the commonly referred icons for being “online” can be misunderstood
in western cultures if they would be colored red (see fig. 15), as that color has many cultural conventions linked to it (Norman 1999).

Something that we observed was that idiomatic icons, such as a warning triangle provides a strong initial indication of what type of action that had occurred, but it needs helping text to clarify its meaning.

**Complementing Icons**

Using text presents challenges in itself. In our tests, we saw that it suffers from several of the problems that icons do, and the choice of wording proved to be very important when designing highly contextual interfaces. Just like icons can be metaphorical, words can be too and be very open to interpretation by the user.

This became very apparent when we were to name the function for seeing recent events in the alarm system. The initial term "notifications" proved not to be powerful enough in a home-security context, while common icons to illustrate this functionality in the form of a megaphone or bell proved to be too powerful since they were already filled with meaning and value.

More powerful names e.g. alerts or warnings also provide challenges as these terms are very leading, and gives the user a clear idea of what type of information that will be shown. Based on our tests these kinds of words make the user expect only serious events like burglary- or fire alarms to be found.

This also applies to words like "news", as it is a wide subject and does not tell the users what they will find by selecting it. In our context, it could be highly serious news concerning the security of the system and firmware updates, but it could also be a blog about things that are happening at the alarm-company.

**Testing your icons**

Working with the RITE method proved to be a great asset in our user tests. It gave us the possibility to iterate away problems in our prototype that otherwise would have stayed present in all our user tests across the entire
phase, impacting the testers and thereby the data they would be able to give us. Considering the short timeframe we had to develop prototypes and perform user tests this could have had major consequences as we would not be able to develop a third prototype or squeeze in more rounds of user testing.

We also needed to arrive at working prototypes quickly in order to get feedback from users early on in the design process, something that the RITE method allowed us to do, while still allowing us to streamline the prototype to highlight the specific parts we wanted to research.

Impact of Hierarchy

We observed that users who understood the top layer icons in the navigation menu had a higher success-rate of relating to the icons further down the hierarchy. For instance, if a user successfully navigates to what he or she believes to be a history panel, then there are already clues there for what functionality to expect from the icons in that panel.

By implementing visual cues and text in the navigational menu, the risk of misunderstanding underlying views is reduced. Failing to do so will have a negative impact on the user experience and in some cases their entire mental model (Blackwell 2006).

6 Conclusion

In this paper we have tried to research and discuss the following question:

"How can we design icons to reduce the risk of their perceived functionality being misinterpreted by new users of icon-based interaction?"

We can conclude from our research that icons that single-handedly represent a specific task will be misinterpreted by some of the users, as the perceived functionality is highly personal and based on prior experience and background. Despite warnings about this being raised several times since the introduction of the first GUI, the problem remains today.
Context has a strong impact on how people perceive functionality in icons. Changes in context can affect the user's understanding of an icon and its functionality, and sometimes their entire mental model. Following common practices and guidelines when picking what icons to use could therefore make the user feel unsafe in an application created to make them feel safer.

When picking icons for a specific application context, it proved to be of great value to conduct user tests and to be aware of your user-base. Based on this knowledge you can try to find suitable cultural conventions for the target group. There is no magic formula for choosing perfectly understandable icons across all applications, but it will improve users' initial understanding if the icons and colors are picked accordingly for the presented content.

Specific action icons, such as filtering, proved to be more open for misinterpretation, whereas an idiomatic icon, e.g. the warning-triangle that is being used to alert users that something is wrong is a learned convention that is less likely to be misunderstood. However, the idiomatic icons only provide an initial, but limited understanding of what subject it concerns and need to be combined with visual cues and text in order to be effective. It is important to note that these need to be picked with the same consideration as the icon itself.

By knowing common pitfalls such as not using a megaphone as a notification metaphor in a security context, the designer has a greater chance of avoiding misinterpretations from the user and thereby giving them the means of understanding the designer's conceptual model.

Skeuomorphic elements, in the type of direct replications of physical products, did not raise the sense of security towards the application in our user tests, but it did highlight the importance of visual coherency. As capturing visual cues from the physical product and keeping them in line with the digital does in the context of security-based applications increase the sense of trust.
7 Further Research

We have concluded that the ways users interpret icons and their functionality are highly personal. Therefore trying to find a solution that fits all could be time consuming and end up being pointless, something that we noticed during our design process, as we made a big effort in finding widely understood icons, independent of context.

Instead of trying to find a solution that fits all, a way to tackle it could be by building interfaces that adapt their layout and elements to the needs of the user or context. By doing so, we can avoid the common pitfalls of using metaphors while still giving new users the support they need to establish a correct mental model. Although the current study is based on a small sample of participants, we suggest further research in the area of Adaptive User Interfaces (AUI's).

Moreover, wearable technology is on the uprising and is entering the consumer market. This is an area where icons will have a major impact on the user interfaces as smart-watches and glasses have a smaller screen estate than mobile phones which puts more pressure on carefully picked icons, as there are fewer possibilities to use supportive text to clarify them.

In our attempt to study which impact skeuomorphic elements had on people’s feelings towards applications and their functionality, we observed that a visual coherency between physical products and digital applications seems to be a field of more interest, than mimicking real-world objects with high fidelity. Because of our limited time frame we did not have time to research this any further, but we advise anyone interested in the subject to do.
8 References

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### 8.2 Online Sources


8.3 Figures


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10. Examples of icons used in our prototype, icons from: *Fontawesome*  
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11. Tree from one of our brainstorming sessions.

12. First prototype news view, icons from: *Fontawesome*  
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13. First prototype notification view, icons from: *Fontawesome*  
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14. First prototype filter view, icons from: *Fontawesome*  
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17. Second prototype login and welcome view.

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