

Introduction to the Psychology of Design

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Introduction

We want to design products, software, websites and applications that are easy to use and engaging. That means we need to know about people. If we know about psychology research we can apply the knowledge of how people think, see and remember when we design. Then, we will be sure that our designs are usable and engaging. This module provides a background and foundation in the psychology of design.

Objectives

The objectives of this module are as follows. When you have completed this module you will be able to:

1. describe the research on how people see and how to apply that to design
2. describe what we know about human memory and avoid overloading a person's memory
3. describe the critical factors in how people think and how that relates to design
4. describe how context affects how people act, and learn how to take the user's context into account when designing
5. describe the latest research in decision-making and understand how that research affects design

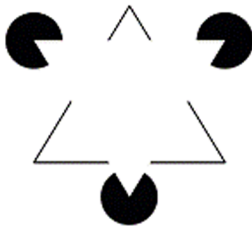
1. Vision

Vision trumps all the senses. Half of the brain's resources are dedicated to seeing and interpreting what we see.

1.1. Our brains rule our vision

We think that our brain processes exactly what our eyes see, but the brain is constantly interpreting everything it sees. Take, for example, Figure 1:

Figure 1



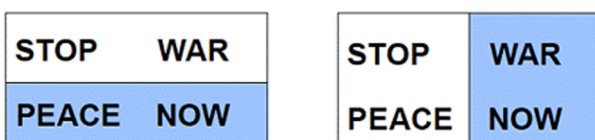
What do you see? Your first reaction is probably that you are looking at a triangle with a black border in the background and a white triangle upside down on top of it. Of course that is not really what is there, is it? What is there are some partial lines and some partial circles. Your brain creates the shape of an upside down triangle out of blank space, because that is what it is expecting to see. This particular illusion is called a Kanizsa triangle, named after an Italian psychologist that first came up with it in 1955.

Our brain creates shortcuts in order to try and quickly make sense of the world around us. It uses rules of thumb, based on past experience, to make guesses about what it sees. Most of the time that works, but sometimes it causes errors.

You can influence what people see, or think they see, by using shapes and colours.

Figure 2 shows how colour can be used to draw attention to one message over another.

Figure 2



You can use borders and colour to draw someone's attention to certain information.

1.2. Peripheral vision

Peripheral vision is important for us to understand the context of a screen or page.

We have two types of vision: central and peripheral.

- Central vision is the vision we use when we look at something directly and see the details.
- Peripheral vision is the rest of the visual field that is visible, but we are not directly looking at.

Peripheral vision is more important in understanding the world around us than most people realise. We get information on what type of scene we are looking at — the gist of what we are looking at — from our peripheral vision.

Larson and Loschky (2009) showed people photographs of common scenes, for example a photograph of a kitchen or a living room. In some of the photographs the outside of the image was obscured, and in others the central part of the image was obscured. The images were shown for very short lengths of time and were purposely shown with a grey filter so they were somewhat hard to see.

Figure 3 shows the image where central vision was missing:

Figure 3

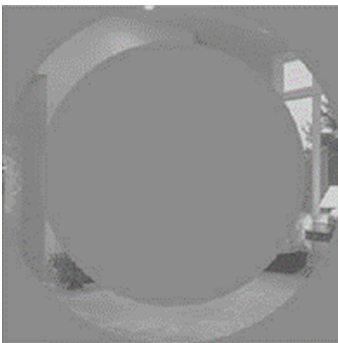


Figure 4 shows the image where peripheral vision was missing:

Figure 4



If the peripheral part of the photo was missing, people could still identify what they were looking at. But when the central part of the image was missing then they couldn't say what room or scene they were looking at. Their conclusions are that central vision is the most critical for specific object recognition, but peripheral vision is used for getting the gist of the scene.

Peripheral vision is especially sensitive to movement, so if you want people to be able to concentrate on a certain part of the screen, then you should avoid animation or blinking going on in their peripheral vision.

People use both central and peripheral vision when they look at a computer screen. They will likely decide what the page is about (in other words, what the gist of the page or site is) through a quick glimpse of what is in their peripheral vision.

1.3. Fusiform facial area

Although the visual cortex is huge and takes up a large amount of brain resources, there is a special part of the brain outside of the visual cortex whose role it is to recognize faces. It is called the fusiform face area or FFA for short (Kanwisher, 1997). This special part of the brain is also near the amygdala, which is the emotional centre of the brain. This means that faces grab attention, are recognized quickly and bypass the usual brain interpreting channels.

Faces will be recognized and reacted to on web pages faster than anything else on the page (at least by people who are not autistic).

Faces looking right at you will have the most emotional impact on a web page, probably because the eyes are the most important part of the face.

If you make the face on a web page look at another spot or product on the page, then the viewer will also tend to look at that product.

1.4. Affordances

Have you ever used a door handle that doesn't work the way it should — for example, it has a handle that looks like you should pull it, but in fact you need to push it? The size and shape of doorknobs invite us to grab and turn them; the curved handle on a coffee mug tells us to curl a few fingers through it and lift it up. If the item, like the door handle, gives you cues that don't work, you get annoyed and frustrated. These cues are called affordances.

James Gibson wrote about the idea of affordance, in a book in 1979. He described affordances as action possibilities in the environment. In 1988 Don Norman modified the idea of affordances in his book *The Design of Everyday Things*. He referred to the idea of perceived affordances: If we want people to be able to take action on an object, whether in real life or on a computer screen, we need to make sure that people can easily perceive, figure out and interpret what an object is and what they can and should do with it.

If you are designing computer screens you will want to think about the affordances of objects on the screen.

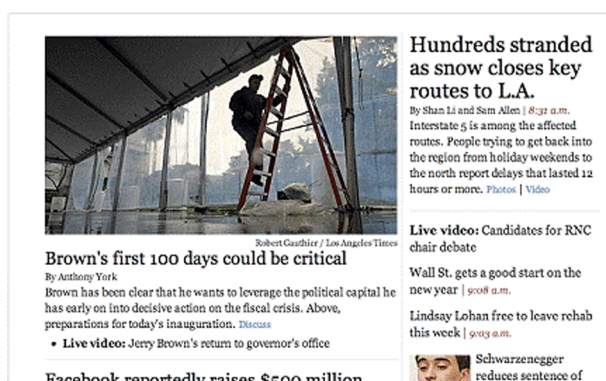
For example, have you ever thought about what makes people want to click on a button? If you use certain cues in the shadow of a button it looks like it can be pushed in, the way a button on an actual device can be pushed in.

You can simulate the shadows that are a cue for pressing a button online too. Think about the affordance cues you are providing when you design. By giving cues of what people can do with a particular object on the page or device you make it more likely that someone will take that action.

1.5. Physical proximity

People believe that things that are close together belong together. If two items are near each other (photo and text for example), then people assume they go together. This is strongest for items that are together left to right. In Figure 5 the photo goes with the text that is below it.

Figure 5



Hundreds stranded as snow closes key routes to L.A.
By Shan Li and Sam Allen | 8:37 a.m.
Interstate 5 is among the affected routes. People trying to get back into the region from holiday weekends to the north report delays that lasted 12 hours or more. [Photos](#) | [Video](#)

Brown's first 100 days could be critical
By Anthony York
Brown has been clear that he wants to leverage the political capital he has early on into decisive action on the fiscal crisis. Above, preparations for today's inauguration. [Discuss](#)
• **Live video:** Jerry Brown's return to governor's office

Facebook reportedly raises \$500 million

Live video: Candidates for RNC chair debate

Wall St. gets a good start on the new year | 9:08 a.m.

Lindsay Lohan free to leave rehab this week | 9:03 a.m.

Schwarzenegger reduces sentence of

But because people read left to right and because there is very little space between the photo and the text to the right, people will expect that the photo and text to the right belong together.

If you want items, whether pictures, photos, headings or text, to be seen as belonging together, then you should put them in close proximity.

Before you use lines and boxes to separate or group items together, try experimenting with the amount of space first, then decide whether you still need lines or boxes. Sometimes all you need is to change the spacing and then the line or box may not be necessary, thereby reducing the visual clutter of the page.

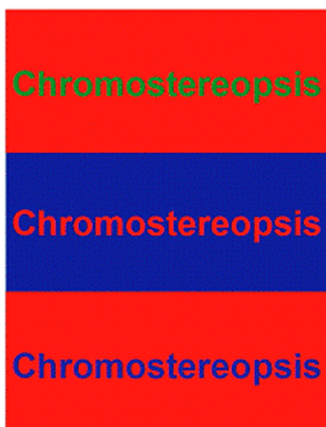
Put more space between items that don't go together and less space between items that do. This sounds like common sense, but you will see that many web page layouts ignore this idea.

1.6. Avoid chromostereopsis

When lines or text of different colours are projected or printed, the depths of the lines may appear to be different. One colour may jump out while another colour appears recessed. This effect is called chromostereopsis. This effect is strongest with red and blue, but it can also happen with other colours, for example, red and green. These colour combinations can be hard and tiring to look at or to read.

Figure 6 shows an example of red and blue, and red and green chromostereopsis.

Figure 6



Avoid putting blue and red or green and red sections of colour near each other on a page or screen.

Avoid blue or green text on a red background and red or green text on a blue background.

1.7. Design for people who are colour-blind

11.9 per cent of men and .5 per cent of women are colour-blind. The term colour blindness is actually a misnomer. Most people who are colour-blind are not blind to all colours, but really have a colour deficiency that makes it hard for them to see differences between some colours. Most types of colour blindness are hereditary, although some can be acquired through disease or injury. Most of the colour genes are on the X chromosome. Since men have only one X chromosome and women have two, it is more likely for men to have problems with colour vision than it is for women.

There are many different kinds of colour blindness, but the most common is a difficulty distinguishing between reds, yellows and greens. This is called red-green colour blindness. Other forms, such as problems distinguishing blues from yellows or where everything looks grey, are very rare.

If you use colour to imply a certain meaning (for example, items in green need immediate attention), think up a redundant coding scheme (items in green and with a box around them need immediate attention).

Consider using colours for your coding that work for everyone, for example varying shades of browns and yellows, and avoid reds, greens, and blues.

Tip

Check your images and/or your websites with www.vischeck.com or www.colorfilter.wickline.org to see how they will look to someone who is colour-blind.

1.8. Colours have meanings that vary by user groups and culture

Colours have associations and meanings, for example, red means in-the-red or financial trouble or it could mean danger or stop. Green means money or go.

You want to pick colours carefully since they have these meanings. And different colours might mean different things to different sub-groups.

If you are designing for various cultures around the world, then you also have to consider the colour meanings in other cultures.

Some colours have similar meanings everywhere, for example, gold stands for success and high quality in most cultures, but most colours have different meanings in different cultures. In some cultures, for example, white stands for purity and is used at weddings, but in other cultures white is the colour used for death and funerals.

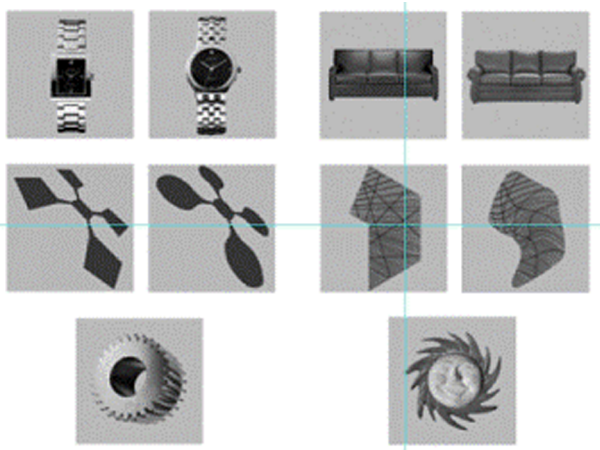
Choose your colours carefully, taking into account the meaning that that colour may invoke. David McCandless of Informationisbeautiful.net has a colour chart that shows how different colours are viewed by different cultures.

Pick a few major cultures/countries that you will be reaching with your design and check them on David McCandless's cultural colour chart to be sure you do not have some unintended colour associations for that culture.

1.9. People prefer objects with curves

Bar (2006) conducted research on objects with curves versus straight edges and objects with smooth versus jagged edges. People preferred objects that were curved and smooth. Figure 7 shows some of the images used in the research.

Figure 7



If you are a visual designer or work with a visual designer, consider using curved shapes for buttons, icons and borders.

1.10. All capital letters are not necessarily inherently harder to read

You have probably heard that all capital letters are harder to read than using upper and lower case letters (mixed case). In fact, you've probably even heard some kind of % cited, such as "between 14-20% harder". The story that circulates (that is not completely accurate) is that you read by recognizing the shapes of words and groups of words. Words that are mixed case have unique shapes. Words that are in all capital letters all have the same shape: a rectangle of a certain size. The theory is that this makes words displayed in all uppercase harder to read than mixed. Mixed case words are easier to read because they make unique shapes, as demonstrated by the picture below.

Figure 8



The shapes explanation sounds plausible, but it is not really accurate. There isn't research exactly showing that the shapes of words make reading more accurate or faster. The theory of word shapes comes from a psycholinguist named Cattell who came up with that theory in 1886. There was some evidence for it, but more recent research (Paap 1984, Raynor, 1997) shows that what we are actually doing when we read is recognizing and anticipating letters. And then based on the letters, we recognize the word. Reading is not as fluid as it seems.

When we read, we have the feeling that our eyes are smoothly moving across the page, but that is not what is happening at all. Your eyes move in quick sharp jumps with short periods of stillness in between. The quick jumps are called saccades¹ and the moments of stillness are called fixations². During the saccades, you can't see anything — you are essentially blind. Fortunately these saccades are really fast so you are not blind for long. They are so fast that you don't even realise they are happening. During most of the saccades (jumps), you move forward, but 10-15% of the time the saccades move backwards and you re-read letters and words.

⁽¹⁾About 7-9 letters worth.

⁽²⁾About 250 milliseconds long.

1.11. You use your peripheral vision when you read

A saccade jumps over about 7-9 letters, but your perceptual span is actually double that. When you are reading your eyes are looking ahead using your peripheral vision to see what is coming next (Goodman, 1996). You read ahead about 15 letters at a time. When you view those 15 letters you usually view them to the right (assuming you are reading left to right), although now and then your saccade jumps backwards and you re-read a section of letters. Although you read ahead about 15 letters at a time, you are only getting meaning for a part of that span. From letters 1 to 7 you are picking up the semantic (meaning) cues of what you reading. From letters 8 to 15 you are just recognizing letters.

All capital (uppercase) letters ARE actually slower for people to read, but only because we aren't used to them. Mixed case text is only faster to read than uppercase letters because of practice. Most of what you read is mixed case and so you are used to it. If people practice reading text that is in all capital letters they can get to the point where they are reading that text as fast as they usually read mixed case. This doesn't mean you should start using uppercase or capital letters for all your text. People are not used to reading that way, so it will slow them down and these days it is perceived as shouting.

Save all capital letters for headlines and when you need to get someone's attention, for example, when someone is about to delete an important file on their computer.

Bibliography

Kevin Larson wrote a great article summarising all the research on this topic, and you can find that article at: <http://www.microsoft.com/typography/ctfonts/wordrecognition.aspx>

1.12. Reading and comprehending are two different things

If you are a biologist, then this paragraph might make sense right away:

The regulation of the TCA cycle is largely determined by substrate availability and product inhibition. NADH, a product of all of the dehydrogenases in the TCA cycle, with the exception of succinate dehydrogenase, inhibits pyruvate dehydrogenase, isocitrate dehydrogenase, α -ketoglutarate dehydrogenase, while succinyl-CoA inhibits succinyl-CoA synthetase and citrate synthase.

But if you are not a biologist then it might take you a long time to understand what that paragraph says. You can technically read the paragraph, but that doesn't mean you understand it. New information is assimilated more thoroughly when there are existing cognitive structures that the new information can be plugged into.

You can calculate how readable your text is. The most common formula for calculating the readability of a particular passage of text is the Flesch-Kincaid method. There is a reading ease formula and also a reading grade level score.

The higher the score the easier the passage is to read. Low scores mean the passage is hard to read.

1.13. Use a non-decorative font

People have been designing fonts for hundreds of years. There are fierce debates about which font is better, easier to read or more appropriate. Some of these debates are literally hundreds of years old.

One debate centres around serif versus sans serif fonts. In French, the word *serif* means decoration, and the word *sans* means without. So a serif font has decorative edges and flourishes and a sans serif font does not.

For many years it was argued that sans serif fonts were easier to read because they were plainer. The opposite was also argued: that serif fonts were easier to read because the flourishes at the ends of the letters drew the eye towards the next letter. Research shows that there is no difference in comprehension, reading speed or preference for serif or sans serif fonts.

Flesch-Kincaid method

Some word processing software has the Flesch-Kincaid formula built in. Or you can use this online tool:

<http://www.standards-schmandards.com/exhibits/rix/index.php>

to calculate the reading level of a particular passage.

Our brains form a memory pattern of what each letter usually looks like. When we see something similar, our brain recognizes the pattern. Designers use fonts to evoke a mood, brand or association. Some font families invoke a time period (old fashioned versus modern), while others invoke seriousness or playfulness. In terms of readability, however, the research shows that the font you use is not that critical as long as it is not so decorative as to make it hard to recognize letters. Some fonts interfere with the brain's ability to recognize patterns.

1.14. Hard to read = hard to do

If a font is too hard to read then it transfers that feeling of difficulty to the meaning of the text.

Schwarz and Song (2008) gave people instructions to read about how to do a physical exercise. If the instructions were in an easy to read font (Arial) people estimated that it would take about 8 minutes to do the exercise and that it wouldn't be too difficult. They were willing to incorporate the exercise into their daily exercise plan. But if the instructions were given in an overly decorative font (Brush Script MT Italic) people estimated it would take almost twice as long, 15 minutes, to do the exercise and they rated the exercise as being difficult to do. They were less likely to be willing to incorporate it into their routine.

It doesn't matter whether you choose a serif or a sans serif font in terms of readability. But if you use an unusual or overly decorative font you might interfere with pattern recognition and then you will slow down reading. And, if you use a font that is hard to read, people will transfer that feeling of hard to read to the meaning itself and decide that what the text is talking about is hard to do or understand.

1.15. Consider using a font with a larger x-height

The font size needs to be big enough so that people can read it without strain. It is not just older people that need fonts to be bigger. Younger people also complain when font sizes are too small to read.

Some fonts can be the same size, but look bigger, due to the x-height. The x-height is literally the height of the small letter x in the font family. Different fonts have different x-heights and, as a result, some fonts look larger than others, even though they are the same font point size.

Some of the newer font families, such as Tahoma and Verdana, have been created with large x-heights so they will be easier to read on a screen.

Bibliography

For more information on font type, typography and readability here are two great websites:

<http://typoface.blogspot.co.uk/2009/12/typeface-or-font-readability-which.html>
<http://www.alexpoole.info/academic/literaturereview.html>

Figure 9

All the fonts in this illustration are the same size, but some look larger than others because the x-height of different font families vary. This one is Arial.

All the fonts in this illustration are the same size, but some look larger than others because the x-height of different font families vary. This one is Times New Roman.

All the fonts in this illustration are the same size, but some look larger than others because the x-height of different font families vary. This one is Verdana.

All the fonts in this illustration are the same size, but some look larger than others because the x-height of different font families vary. This one is Tahoma.

1.16. People read faster with a longer line length, but prefer shorter

Dyson (2004) has conducted research on line length and she combed other research studies to see what line length is best. The research shows that 100 characters per line is the optimal length for on-screen reading speed; but it is not what people prefer. People read faster with longer line lengths (100 characters per line), but they prefer a short or medium line length (45 to 72 characters per line).

Longer line lengths are easier to read because they interfere less with the flow of saccades and fixations. Every time you get to the end of a line you interrupt the regular saccade and fixation eye movement. If you have a shorter line length you have more of these interruptions for the total length of the piece you are reading.

The research also shows that people can read one wide column faster than multiple columns, but they prefer multiple columns. If you ask people which they prefer, they will say multiple columns with short line lengths. Interestingly, if you ask them which they read faster, they will insist it is also the multiple columns with short line lengths, even though the data shows otherwise.

So do we give people what they prefer or go against their preferences? If speed is a definite issue then use a line length of 100 characters per line. If speed is not a critical factor then use shorter line lengths, from 45 to 72 characters per line. If there is a lot of text to read, for example a multi-page article, then consider using multiple columns in addition to a short (45 characters per line) line length.

2. Memory

Humans have limited memory. You have to design for memory limitations to be sure that you are not overwhelming the user's memory limitations.

2.1. Working memory is limited

We've all experienced this moment: You are on the phone talking to someone who is giving you a message. They are telling you that you need to call someone right away and they are giving you the name and number you are supposed to call. But you don't have a pen or paper to write down the information. It is very easy to forget the name and number in this situation. We resort to strategies to remember the information, such as repeating the name and number over and over. We try to get off the phone as quickly as possible so we can make the call right away while the phone number is still running through our head.

We know that our ability to remember this type of information in this situation is not very reliable. This type of quick memory that you need for less than a minute, is called working memory.

There is only so much we can hold in working memory before we forget it entirely and information in working memory is easily interfered with.

For example, if we are trying to remember a name and number, and someone starts talking to us at the same time, we will forget the name and number.

If we don't concentrate we will lose it from working memory. This is because working memory is tied to our ability to focus attention. In order to maintain information in our working memory we must keep focusing our attention on it.

If we are under stress, then our working memory is even more limited. This is one reason why people who are using software under stress will make more errors and get more frustrated.

Don't ask people to remember information from one place to another.

For example, to read letters or numbers on one page and then enter them onto another page or form.

If you do, it is likely that they will forget the information and get frustrated.

If you are asking people to remember things in working memory, don't ask them to do anything else until they've completed the one task. Remember that working memory is sensitive to interference. Too much sensory input means the person can't focus attention.

2.2. We can deal with only 4 items at once

You may have heard the phrase: "The magic number 7 plus or minus 2".

Miller (1956) did research and wrote a research paper showing that people can remember from 5 to 9 (7 plus or minus 2) things, and that people can process 7 plus or minus 2 pieces of information at a time. But a psychologist named Baddeley (1994) questioned the 7-plus-or-minus-2 idea. Baddeley conducted a long series of studies on human memory and information processing. He and others showed that the magic number is 4.

We can hold 3–4 things in working memory as long as we aren't distracted and our processing of the information is not interfered with.

The 4-limit rule works not only for working memory, but for long-term memory too. Mandler (1969) showed that people could memorise information in categories and then retrieve it from memory perfectly if there were only 1, 2 or 3 items in a category. The number of items recalled dropped steadily when each category contained more than 3 items. If there were 4–6 items in the category, then people could remember 80% of the items and it went down from there (down to 20% if there were 80 items in the category).

Broadbent (1975) asked people to recall items in different categories, for example, the Seven Dwarfs, the seven colours of the rainbow, the countries of Europe or the names of current shows on TV. People would remember the items in bursts of 2, 3 or 4 items clustered together.

If you want people to retain all the information, make them deal with less than 4 items, that would actually be a great idea, but you don't have to be that drastic. You can use more pieces of information as long as you group it and divide it into chunks. Each chunk should only have 4 items.

Eliminate memory load whenever possible. Many interface design guidelines and interface features have evolved over the years to mitigate issues with human memory. Instead of cryptic codes in the legacy green screen systems, there are now meaningful labels. Instead of making users go to a separate help screen, now there are drop-down lists. Follow these guidelines to minimise memory load.

3. Cognition

Understanding how people think and organise information is critical to design an interface that matches how they think.

3.1. Bite-sized chunks of information are best

People can only process small amounts of information at a time. One mistake that designers sometimes make is to give too much information all at once.

The official term that is used to describe providing just the amount of information people need at one moment is progressive disclosure.

By giving information little by little, you prevent overwhelming the user and also allow for the needs of different people — some people may just want a high level overview, whereas others are looking for all the detail. Start with a small amount of information and then let people choose; for instance, let them click on a link if they want more.

Doesn't this mean that people are going to have to click many links before they get to the information they want? Isn't it important to use the one-click rule, meaning that people can get to what they want in one click? The number of clicks is not the important criteria.

Progressive disclosure requires multiple clicks. People are very willing to make multiple clicks, in fact they won't even notice they are making the clicks, if they are getting the right amount of information at each click to keep them going down the path. If you have to make a trade-off on clicks versus thinking, use more clicks and less thinking.

Progressive disclosure does assume that we know what most people want most of the time. If you haven't done your research on that, then you could end up with a frustrating site, with most people having to spend a lot of time searching for the information they are looking for. Progressive disclosure only works if you know what most people will be looking for at each part of the path.

3.2. Load trade-off

Let's say we are designing software for paying bills online. The user has to think about what bills need to be paid when, look up the check book balance, decide how much to pay on credit cards and push the right buttons to get the payments processed. As the user performs this task, there are things to think about and remember (cognitive), things to look at on the screen (visual), buttons to press, mouse movements and typing (motor).

In human factors terminology these are called loads. The theory is that there are basically three different kinds of demands or loads that you can make on a person: cognitive (including memory), visual and motor.

Each of these loads uses up different amounts of mental resources. We use up more resources when we ask people to look at something or find something on a screen (visual) than when we ask them to press a button or move a mouse (motor). We use up more by asking them to think, remember or do a mental calculation (cognitive) than when we ask them to look at something on a screen (visual). So, from a human factors point of view, the order of the loads from most expensive to least is:

- Cognitive (most expensive)
- Visual
- Motor (least expensive)

From a human factors point of view, when you are designing a product, application or website, you are always making trade-offs. If you have to add a few clicks, but it means that the person doesn't have to think or remember as much, that is worth it, because adding clicks is less of a load than thinking.

Although motor loads are the least expensive of the three loads, you often want to reduce them. One way to reduce the motor load is to make sure that the targets you are asking people to hit aren't too small or too far away.

For example, when you ask people to move their mouse across a screen and click on a button or a small arrow on a drop down box to show a list of choices.

There is actually a formula that can be used to figure out how large a target should be in order for someone to be able to reliably reach it while moving a mouse across the screen. It is called Fitts's law.

The figure shows the formula for Fitts's law.

$$T = a + b \log_2 \left(1 + \frac{D}{W} \right)$$

where:

T is the average time taken to complete the movement (sometimes called MT for movement time)

a is the start/stop time of the device (intercept) and b stands for the inherent speed of the device (slope)

D is the distance from the starting point to the centre of the target

W is the width of the target measured along the axis of motion.

The basic idea to keep in mind is that there is a relationship between speed, accuracy and distance.

For example, let's say that you have a small arrow on the bottom right of the screen and someone has to move the mouse from the top left to the bottom right to click on the small arrow. Fitts's law will tell us that they will probably overshoot the arrow if they move quickly. They will then have to back up and go to the arrow after overshooting.

3.3. Sometimes you want to increase loads

Most of the time we are looking to reduce the loads (especially cognitive and visual loads) to make the product easier to use. But sometimes we want to increase the load. For example, to grab someone's attention you might put more visual information (pictures, animation, a video) and thereby increase the visual load of the product.

The best example of purposely increasing loads is gaming. A game is an interface where one, two or three of the loads have been intentionally increased in order to provide challenge. Some games have high cognitive loads because you have to figure out what is going on. Some have high visual loads, where you have to find things on the screen, and some have high motor loads, where you have to use the keyboard or a separate device to move the cursor, or shoot the villains. Many games increase more than one load, for example, games that have both visual and motor challenges.

4. Context

When you make design decisions, it is important to design for the context of the user. You can't ensure that a product, software or device is easy to use and engaging without taking into consideration the context of use. Context includes such things as: who the users are, where they are, what are their particular goals and what is their emotional environment, for example, stress.

4.1. Mental models

A mental model represents a person's thought process for how something works. Mental models are based on expectations and past experience. People decide what to do, what action to take and what to pay attention to, based on their mental models of how things work.

Users create mental models very quickly, often before they even use the software, web page or device that you have designed. Users' mental models come from their prior experience with similar software or devices, assumptions they have, things they've heard others say and also from their direct experience with the product or device. Mental models are subject to change. Users refer to mental models to predict what the system, software, or product is going to do or what they should do with it.

In order to understand why mental models are so important to design, we also have to understand what a conceptual model is and how it is different from a mental model.

A mental model is the representation that people have in their minds about the object they are interacting with.

A conceptual model is the actual model that is given to the person through the design and interface of the actual product. We design an interface and that interface communicates the conceptual model of the product.

If there is a mismatch between people's mental model and the product's conceptual model, then the product or website will be hard to learn, hard to use or not accepted. How do mismatches occur? Here are some examples:

The designers thought they knew who would be using the interface and how much experience they had with interfaces like this; they designed according to those assumptions without testing them and it turns out their assumptions were wrong.

The audience for the product or website is varied. The designers designed for one persona or type of audience, and the mental model and conceptual model match for that group, but not for others.

There were no real designers. The conceptual model wasn't really designed at all. It was just a reflection of the underlying hardware or software or database. So the only people whose mental model it fits are the programmers. If the audience is not the programmers then you are in trouble.

Sometimes you know that the mental model of the target audience will not fit the conceptual model and, instead of changing the design of the interface, you want to change the person's mental model so that it matches the conceptual model you have designed. The way to change a mental model is through training. One of the best purposes of training on a new product is to adjust the audiences' mental model to fit the conceptual model of the product.

You may be familiar with the term user centred design (UCD). A UCD process is a set of tasks and activities that interface designers or usability specialists conduct in order to make sure a website or product is easy to learn and use. Much of what the UCD process is about either: a) understanding what the users' mental models are (with task analysis, observations, interviews, etc.) or b) designing a conceptual model to fit the users' mental model (interface design, iterations, validation testing, etc.).

4.2. Design for a particular user group

You probably have more than one type of user that you are designing for. User Experience (UX) professionals develop personas so that they can keep representative user groups in mind when designing. If you have more than one user group — more than one persona — then you will need to decide which one is the most important one for the particular task you are designing.

4.3. Be careful of your assumptions

It is natural for us, during the design phase, to design controls, pages and screens in a way that makes sense to us. This can be dangerous, however, since we are likely not the same as our users. For example, research shows that there are age differences in how people respond to technology. Different generations respond differently and have different mental models. Someone who is 15 has a different mental model from the mental model of someone who is 25, or 45 or 65. If you are 45 and designing for people who are older or younger than you, then what makes sense to you might not make sense to someone of a different generation.

Remember

The user is not like me.

4.4. Environmental factors

There are many factors in someone's environment that we may have to take into account when we are designing. If we are designing a mobile app, we have to take into account that people might be in a noisy area and not be able to hear audio beeps, cues or content. Or they might be using the app while moving and not be able to give more than a brief glance at the screen or they may not be able to do more than tap a few buttons.

Sometimes we have to design for special environments, such as special lighting in an operating room at a hospital.

It is important for you to know as much as possible about the environment before you design.

4.5. Stress

When people are under stress they react differently to everything, including the websites, software or devices that we design. Stress takes many forms. People might be stressed because they are rushed or because the environment is noisy. They might be stressed because they are anxious or scared. Someone who is looking for a doctor online because they have a sick child that is crying sitting next to them will be stressed. A customer service representative who has an angry customer on the phone and is trying to use the call centre software will be stressed.

Here is what happens when people are under stress:

- They don't see things that are on the screen.
- They make a lot of mistakes.
- They tend to do the same things over and over even if they keep getting error messages.

If you know that people are stressed, then you have to design the pages, screens or device controls so that they are very easy to use. You have to put less information on the screens and have people make only one decision at a time.

4.6. Social factors

People are social animals. They will often take actions in order to communicate with others. They will also be affected by what other people do.

4.6.1. When people are uncertain, they turn to others to decide what to do

Latane and Darley (1970) set up ambiguous situations to see if people were affected by what others around them were or were not doing. Participants in the research would go into a room, supposedly to fill out a survey on creativity. In the room would be one or more other people, pretending they were also participants, but who were really part of the experiment. Sometimes there would be one other person in the room, sometimes more. While people were filling out their creativity survey, smoke would start to come into the room from an air vent. Would the participant leave the room? Go tell someone about the smoke? Just ignore it?

What action, if any, the participant took depended on the behaviour of the other people in the room, as well as how many other people were there. The more people and the more the others ignored the smoke, the more the participant was likely to do nothing. If the participant was alone, he or she would leave the room and notify someone. But if there were others not reacting in the room, then the participant would do nothing. The name used for how other people's actions and views affect our actions and views is social validation.

At websites, social validation is most in evidence with ratings and reviews. When we are unsure about what to do or buy, we look to testimonials, ratings and reviews to tell us how to behave.

4.6.2. The strong-tie group size limit is 150 people

Evolutionary anthropologists study social groups in animals. One question they have been trying to answer is whether there is a limit on how many individuals different species have in their social group. Robin Dunbar (1998) studied different species of animals. He wanted to know if there was a relationship between brain size (specifically the neo-cortex) and the number of stable relationships in social groups. He came up with a formula for calculating the limit number for different groups. Anthropologists call this the Dunbar number for the species.

Based on his findings with animals, he then extrapolated to what the number would be for humans. Dunbar calculated that 150 people is the social group size limit for humans. (To be more exact, he calculated the number at 148, but rounded it up to 150).

The limit specifically refers to the number of people with which you can maintain stable social relationships. These are relationships where you know who each person is and how each person relates to every other person in the group.

Research example

Reviews by people like us are the most influential. Chen (2008) researched three kinds of ratings and reviews at a bookstore website: a) reviews by regular visitors to a website, b) experts on a topic and c) recommendations from the website itself. All three types influenced behaviour, but the reviews by regular people were the most influential.

Dunbar has documented the size of communities throughout different geographic areas and throughout different historical timeframes and he is convinced that this number holds true for humans across cultures, geographies and time frames.

Dunbar assumes that the current size of the human neocortex showed up about 250,000 years ago. So he started his research with hunter-gatherer communities. His observations include: Neolithic farming villages averaged 150 people, as did Hutterite settlements, professional armies from the Roman days as well as modern army units.

150 is the group size for communities that have a high incentive to stay together. If the group has intense survival pressure, then it stays at the 150-member mark, and stays in close physical proximity. If the survival pressure is not intense or the group is physically dispersed, then he estimates the number would be even lower. That means that, for most of us in our modern society, the number would not even be as high as 150. In the world of social media, people have 750 Facebook friends and 4,000 twitter followers. A Dunbar number advocate, however, would respond that these are not the strong, stable relationships that Dunbar is talking about, where everyone knows everyone and people are in physical proximity.

Some critics of the Dunbar number say that what's really important in social media is not the strong ties that Dunbar talks about, but the weak ties — relationships that do not require that everyone knows everyone in the group and that are not based on physical proximity. Jacob Morgan argues that the reason that social media is so interesting is that it allows us to quickly and easily expand these weak ties and that those are the ties that are most relevant in our modern world (weak does not imply less important in this context).

Both Dunbar and Morgan are probably right. There is a limit of 150 people for our survival community in close proximity. If we don't feel that we have that tribe near us, we may feel alienated, isolated and stressed. Larger numbers through social media are likely weak ties.

When you are designing a product that has social connections built in or implied, think about whether those interactions are for strong or weak ties. If you are designing for strong ties you need to build in some amount of physical proximity for people to interact and know each other in the network. If you are designing for weak ties, do not rely on direct communication or physical proximity amongst all people in a person's network.

Bibliography

For more information, watch this interview of Robin Dunbar:

<http://www.guardian.co.uk/technology/video/2010/mar/12/dunbar-evolution>

And read Jacob Morgan's blog post:

<http://www.socialmediatoday.com/SMC/169132>

4.6.3. People are hard-wired for imitation and empathy

In the front of the brain there is an area called the pre-motor cortex (motor as in movement). This is not the part of the brain that actually sends out the signals that make you move. *That* part of the brain is the primary motor cortex. The pre-motor cortex makes *plans* to move.

Let's say you are holding an ice cream cone, you notice that the ice cream is dripping and you think that maybe you should lick off the dripping part before it drips on your shirt. If you were hooked up to an fMRI machine, you would first see the pre-motor cortex lighting up while you are thinking about licking off the dripping cone and then you would see the primary motor cortex light as you move your arm. Now here comes the interesting part. Let's say it is not you that has the dripping ice cream cone. It is your friend. You are watching your friend's cone start to drip. If you watch your friend lift his arm and lick the dripping cone, a subset of the same neurons also fire in your brain in the pre-motor cortex. Just watching other people take an action causes some of the same neurons to fire as if you were actually taking the action yourself. This subset of neurons has been dubbed mirror neurons.

The latest theories are that these mirror neurons are also the way we empathise with others. We are literally experiencing what others are experiencing through these mirror neurons and that allows us to deeply and literally understand how another person feels.

Don't underestimate the power of watching someone else do something. If you want to influence someone's behaviour, then show someone else doing the same task.

There is research that shows that stories create images in the mind that may also trigger mirror neurons. Use stories if you want to get people to take an action.

Videos at websites are especially compelling. Do you want people to get regular check-ups with their physicians? Then show a video of other people visiting a doctor. Do you want kids to eat vegetables? Then show a video of other kids eating vegetables.

4.6.4. People expect online interactions to follow social rules

When people interact with each other, they follow rules and guidelines for social interaction.

Mirror neurons

VS Ramachandran has a TED talk on mirror neurons:
<http://bit.ly/aaiXba>

Here's an example: You are sitting in a café and your friend Mark comes into the café and sees you sitting by the window. Mark comes over to you and says: "Hi Richard, how are you doing today?" Mark expects you to interact with him and he expects that interaction to follow a certain protocol. He expects you to look at him, in fact to look him in the eye. If your previous interactions have been positive, then he expects you to smile a little bit. Next, you are supposed to respond to him by saying something like: "I'm fine. I'm sitting outside here to enjoy the beautiful weather". Where the conversation goes next depends on how well you know each other. If you are just casual acquaintances, he might wind down the conversation. "Well, enjoy it while you can, bye!" If you are close friends, then he might pull up a chair and engage in a longer conversation.

You both have expectations of how the interaction will go and, if either of you violates the expectations, then you will get uncomfortable. For example, what if Mark starts the conversation as above, with "Hi Richard, how are you doing today?" but you don't respond? What if you ignore him? Or what if you won't look at him? What if you say back: "My sister never liked the colour blue" and stare into space. Or perhaps you give him more personal information than your relationship warrants. Any of these scenarios would make him uncomfortable. He would probably try to end the conversation as soon as possible and likely avoid interacting with you next time the opportunity arises.

The same is true of online interactions. When we go to a website or use an online application, we have assumptions about how the website will respond to us and what the interaction will be like. And many of these expectations mirror the expectations that we have for person-to-person interactions. If the website is not responsive or takes too long to load, it is as if the person we are speaking to were not looking at us or ignoring us. If the website asks for personal information too soon in the flow of the interaction, that is like the other person getting too personal. If the website does not save our information from session to session, that is like the other person not recognizing us or remembering that we know each other.

When we design, we need to think about the interactions that the person will have with the product. Do the interactions follow what would be expected of a person-to-person interaction? Many usability design guidelines for products are actually guidelines that connect to social expectations for interactions.

4.6.5. Speakers' and listeners' brains synchronise up during communication

When we listen to someone talking, our brain starts working in synchronisation with the speaker. Greg Stephens (2010) put participants in his research study in an fMRI machine and had them record or listen to recordings of other people talking. What he found was that, as someone was listening to someone else talk, the brains patterns of the two people started to couple or mirror each other. There was a slight delay, which corresponded to the time it took for the communication to occur. Several different brain areas were synchronised. He compared this with having people listen to someone talk in a language they did not understand. In that case, the brains did not synchronise up.

Synchronising + anticipation = understanding

In Stephen's study, the more the brains were synchronised up, the more the listener understood the ideas and message from the speaker. And, by watching what parts of the brain were lighting up, Stephens could see that the parts of the brain that have to do with prediction and anticipation were active. The more active they were, the more successful was the communication.

Stephens noted that the parts of the brain that have to do with social interaction were also synchronised, including areas known to be involved in processing social information crucial for successful communication, including the capacity to discern the beliefs, desires and goals of others. Stephens hypothesised that mirror neurons are also involved in speaker-listener brain synchronising.

Listening to someone talking creates a special brain synchronising that helps you understand what is being said. Presenting information through audio or video where people can hear someone talking is especially powerful in understanding. If you want people to understand information clearly, don't just rely on reading.

4.7. Emotion and design

People don't just think. They also feel. In addition to understanding your audience's demographics, you need to also understand their psychographics.

4.7.1. Seven basic emotions are universal

Considering how important emotions are in our everyday life, there is not as much research on emotions as you might think. In order to study emotions, it is necessary to define them first. Scientists studying emotions contrast them with moods and attitudes:

Emotions have physiological correlates, expressed physically (gestures, facial expressions); they often result in an action and they result from a specific event.

Moods last longer than emotions, perhaps a day or two; they may not be expressed physically and may not come from a specific event.

Attitudes have a more cognitive, conscious, brain component.

Paul Ekman is the expert in reading emotions in facial expressions. He has two books (2007 and 2009) and is a consultant on Fox for their TV series *Lie to Me*. He has identified seven emotions that seem to be universal:

- Joy
- Sadness
- Anger
- Contempt
- Surprise
- Disgust
- Fear

LeDoux (2000) has shown that you can see certain parts of the brain activate when people feel certain emotions.

According to Ekman's work, there are 40 facial muscles that are the main muscles used in showing emotion.

Facial expressions seem to be universal and so are many vocalisations that are used to express emotions such as crying and laughing (Sauter, 2010), but gestures accompanying emotions are not as universal.

If you are using pictures to communicate, for example, pictures of people at a website, use one of the 7 basic emotions in the picture in order to communicate them most clearly.

People read the 7 basic emotions fairly well from photos. Try to use photos where the expressions look real because people will often be able to detect a fake emotion.

Decide what emotions drive your target audience. In addition to basic demographic information, also identify and document psychographics, for example, what emotions are motivating or will motivate different parts of your target audience?

4.7.2. Anecdotes and stories are more powerful than data

Let's say you have to make a presentation to the heads of departments at work about your latest conversations with your customers. You interviewed 25 customers, surveyed another 100 and have lots of important data to share. Your first thought might be to present a summary of the data in a numerical/statistical/data-driven format, for example:

75% of the customers we interviewed....

Only 15% of the customers responding to the survey indicated...

But this data-based approach will not be as persuasive as anecdotes. You may want to include the data, but your presentation will be more powerful if you focus on one or more anecdotes, for example:

How to read micro-expressions

You can take a one hour online course to learn how to read micro-expressions to tell what people are feeling. Several different research teams around the world are working on software to automate the reading of facial expressions.

“Mary M from San Francisco shared the following story about how she uses our product: ...”

and then go on to tell Mary’s story.

One of the reasons that anecdotes are more powerful than data is that anecdotes are in story form. They will invoke empathy, which triggers emotional reactions. With emotional reactions, people will process the data and the feelings. Emotions will also trigger the memory centres.

Better yet, don’t just tell Mary’s story in the presentation, include a video of Mary telling the story herself. That makes an even more powerful emotional connection.

Information will be processed more deeply and remembered longer if it has an emotional hook. Look for ways to provide a message that will invoke emotions and empathy. Use anecdotes in addition to, or in place of, factual data.

4.7.3. People are programmed to enjoy surprises

Research by Gregory Berns (2001) shows that the human brain is not only looking for the unexpected, it actually craves the unexpected.

Berns used a computer-controlled device to squirt either water or fruit juice into people’s mouths while their brains were being scanned by an fMRI device. Sometimes the participants could predict when they were going to get a squirt, but other times it was unpredictable. The researchers thought that they would see activity based on what people liked. For example, if people liked juice, then they would see activity in the *nucleus accumbens* area of the brain. The *nucleus accumbens* is the part of the brain that is active when people are experiencing pleasurable events.

However, that is not what happened. The *nucleus accumbens* was most active when the squirt was unexpected. It was the surprise that showed activity, not the preferred liquid.

Things that are new and novel will capture attention. Providing something unexpected not only gets attention, but is actually pleasurable. A certain amount of consistency, for example at a website, is a good thing if people are trying to get a task done. But providing new, novel and unexpected content and interactions is important if you want people to try something new or if you want them to decide to come back to see what’s new.

4.7.4. People use look and feel as the first indicator of trust

There isn't a lot of actual research on trust and website design. There are a lot of opinions, but not necessarily much real data. Research by Elizabeth Sillence and her team (2004) provides some solid data, at least in regard to health websites.

Sillence researched how people decide whether and which health websites to trust. Participants in the study were all patients with hypertension. (In previous research Sillence used the topic of menopause and found similar results). In this study participants used websites to look for information about hypertension.

When participants in the study rejected a health website as not being trustworthy, 83% of their comments were related to design factors, such as an unfavourable first impression of the look and feel, poor navigation, colour, text size and the name of the website.

When participants mentioned the features that were relevant to their decision that a website was trustworthy, 74% of their comments mentioned the content of the site, rather than design factors. For example, if the sites were owned by well-known and respected organisations, advice written by medical experts and sites that were specific to them and that they felt were written for people like themselves.

Design factors, such as colour, font, layout and navigation are critical in making it through the first trust rejection phase. If a website makes it through the first rejection cut, then content and credibility become the determining factors as to whether the person trusts the site.

5. Decision-making

The latest research in psychology shows that most decisions are made unconsciously. If you are designing an interface so that people will take an action, you need to understand how people make decisions.

5.1. Most decision-making is unconscious

Let's use the example of someone who is about to purchase a television. He or she does some research on which television to buy, and then makes the purchase. What factors are involved in this decision-making process?

It may not be as careful and logical a decision as we think. We think that people will carefully and logically weigh all the relevant factors before they make their decision. For example, they will have considered the size of television that will work best in a particular room, the brand that is the most reliable, the competitive price, whether this is the best time to buy it, etc. People might consciously consider all those factors, but the research on decision-making, especially the recent research, shows that the actual decision is made primarily in an unconscious way.

Unconscious decision-making includes factors such as:

- What are most other people deciding to buy: "I see that a particular television got high ratings and reviews at the website".
- What will promote consistency in my persona (commitment): "I'm the kind of person that always has the latest thing, the newest technology".
- Do I have any obligations or social debts that I can pay off with this purchase (reciprocity): "My brother and his family has had me over to his house all year to watch the games, I think it is time we had them over to our place to watch, so I'd better get a television that is at least as good as his".
- Fear of loss: "This television is on sale only through the end of the month and, if I don't buy it right now, the price may go up and I might not be able to buy one for a long time".
- And that person's particular drives, motivations and fears.

In order to design a product or website so that it persuades people to take a certain action, we have to know the unconscious motivations of our target audience.

When people tell us their reasons for deciding to take a certain action, we have to take what they say sceptically. As decision-making is unconscious, they may not be aware of the true reasons for their decisions.

Although people are making decisions based on unconscious factors, they will want a rational, logical reason for the decision they made. So we still need to provide the logical rational reasons, although they are not likely to be the actual and most important reasons why people decide to take action.

5.2. People want more choices and information than they can actually process

If we stand in any aisle in many retail stores, we will be inundated with choices. Whether we are buying candy, cereal or jeans, we will likely have a huge number of items to choose from. Whether it is at a retail store or at a website, if we ask someone whether they would like to choose from a few alternatives or have lots of choices, most people will say that they want lots of choices.

Sheena Iyengar's book *The Art of Choosing* details her and others' research on choice. In graduate school, Iyengar conducted what is now known as the jam study. Iyengar and Lepper (2000) decided to test out the theory that if you have too many choices you don't choose at all. They set up booths at a busy upscale grocery store and posed as store employees. They alternated the selection on the table. Half of the time there were six choices of fruit jam for people to try and the other half of the time there were twenty-four jars of jam.

When there were twenty-four jars of jam, 60% of the people coming by would stop and taste. When there were six jars of jam, only 40% of the people would stop and taste. You would think that people would taste more jam when the table had twenty-four different varieties. But they didn't. People stopped at the table, but they only tasted a few varieties whether there were six or twenty-four choices available.

The most interesting part of Iyengar's study is that 31% of the people who stopped at the table with six jars actually made a purchase. But only 3% of the people who stopped at the table with twenty-four jars actually made a purchase. So even though more people stopped by, less people purchased.

We need to resist the impulse to provide a large number of choices to users. If you ask people how many options they want, they will almost always say: “a lot” or “give me all the options”. If possible, limit the number of choices to 3 or 4. If you have to offer more options, try and do so in a progressive way (have people choose first from 3 or 4 options and then choose again from a subset).

In her book, Iyengar discusses an experiment with rats. The rats were given a choice of a direct path to food or a path that had branches and therefore required choices to be made. Both paths resulted in access to the same food in the same amounts. If all the rats wanted was food, then they should take the short direct path. But the rats continuously preferred the path with branches.

In experiments with monkeys and pigeons, the animals learn to press buttons to get food. If given a choice between having just one button or having multiple buttons to choose from, both monkeys and pigeons prefer to have multiple buttons.

And in similar research with humans, people were given chips to use at a casino. They could use the chips at a table that had one roulette wheel or at a table where they could choose from two roulette wheels. People preferred the table with two wheels, even though all three wheels were identical.

Even though it isn't necessarily true, we equate having choices with having control. If we are to feel in control, then we need to feel that our actions are powerful and that we have choices to make. Sometimes having a lot of choices makes it harder to get what we want, but we still want the choices so that we feel in control of the decision. People need to feel that they are in control and that they have choices.

People will not always choose the fastest way to do a task. When we are designing how our users will accomplish a task with our website or product, we may want to offer more than one way, even if the alternative methods are not as efficient, just so that people will have a choice.

Once we have given people a choice, they will not be happy if we take choices away. When we design a new version of a product with improved methods for getting tasks accomplished, it is sometimes a good idea to leave some of the older choices in the product so that people feel they have options.

Activities

(Note: Students can work individually or in pairs for the following exercises. Students can take notes and deliver their results verbally or they can write a summary for each item. Each exercise should take approximately 30 minutes. Students can find their own websites to evaluate or a particular website can be assigned to them).

Vision

Pick a website of your choice and evaluate it for each of the vision factors. Which of the factors does the website do a good job with? Which of the factors does the website do a poor job with? You can answer yes, no or not applicable to this site for each item below:

1. Does what is in peripheral vision give the gist of the website?
2. Do they make use of faces? Are the faces looking right into the camera? Are they large enough?
3. Do they make good use of affordances? Is it clear what is clickable?
4. Do they make appropriate use of physical proximity? Do things that are close together actually belong together?
5. Is there chromostereopsis? Do they have red and blue or red and green foreground and background together, thereby making text hard to read?
6. Are they making good use of colour? Are they careful of cultural meanings of colours like red and black? Have they designed so that people with colour-blindness will be able to use the site?
7. Is the font easy to read? Is it large enough?

Memory, cognition and context

Pick a website of your choice and evaluate it for each of the memory and cognition factors. Which of the factors does the website do a good job with? Which of the factors does the website do a poor job with? You can answer yes, no or not applicable to this site for each item below:

1. Are there more than 3 or 4 choices for the user to make at any given time?
2. Is information provided in small chunks?
3. Are tasks designed so that they fit the user's mental model?

Social, emotional and decision factors

Pick a website of your choice and evaluate it for each of the social and emotional factors. Which of the factors does the website do a good job with? Which of the factors does the website do a poor job with? You can answer yes, no or not applicable to this site for each item below:

1. Does the site make appropriate use of social validation with reviews or testimonials?
 - a) Is there audio or video?
 - b) Does the site make appropriate use of stories?
 - c) Does the site communicate as though the user were communicating with a person rather than with a computer?

Self-evaluation

1. Which of the following statements best describes vision and the brain?:
 - a) The retina of the eye processes and interprets visual information.
 - b) The retina of the eye sends visual information to the brain and the visual cortex interprets what the eyes see.
 - c) The brain sends signals to the retina and the eyes then adjust what they are looking at.
 - d) What you see with your retina is produced visually on your brain as an exact replica.
2. Which of the following statements best describes peripheral vision?:
 - a) Peripheral vision gives us the gist of the scene we are looking at.
 - b) Peripheral vision is the detailed part of our vision.
 - c) Peripheral vision is only important when you are reading.
 - d) Peripheral vision is inaccurate.

3. Which of the following statements is true?:

- a) The fusiform facial area is a special part of the brain that interprets faces.
- b) The fusiform facial area is part of the visual cortex.
- c) The fusiform facial area is only active when you see a fact that is distorted or scary.
- d) The fusiform facial area develops during adolescence.

4. Which of the following is what Don Norman said about perceived affordances?:

- a) "The only thing that is important about an affordance is that people know where they have already clicked at a website".
- b) "Affordances are good to have, but they are not that important. What's most important is that you have included the most important information that fits your target audience".
- c) "Perceived affordance is an archaic topic. It is time for us to move forward to new interfaces and not be so concerned with perceptions of particular objects".
- d) "If we want people to be able to take action on an object, whether in real life or on a computer screen, we need to make sure that people can easily perceive, figure out and interpret what an object is and what they can and should do with it".

5. Which of the following describes chromostereopsis?:

- a) It is a type of colour-blindness.
- b) Using red and blue together on a screen is hard to read.
- c) We can't see colour at night.
- d) Using colour grabs interest and makes people pay attention.

6. Which of the following is true of colour blindness?:

- a) 5 per cent of people are colour-blind, equally divided between men and women.
- b) 11.9 per cent of women and .5 per cent of men are colour-blind.
- c) 11.9 per cent of men and .5 per cent of women are colour-blind.
- d) 5 per cent of men are colour-blind. Colour blindness is only on the Y chromosome, so women are never colour-blind.

7. Which of the following is true about reading text?:

- a) Line length has no effect on reading speed.
- b) People prefer a long line length, but they read faster with a short line length.
- c) People prefer a short line length, but they read faster with a long line length.
- d) People prefer a short line length and they also read faster with it compared to a long line length.

8. Which of the following is true about human memory?:

- a) We can remember between 5-9 things at a time.
- b) We can remember 3-4 things at a time.
- c) We can remember up to 10 things at a time.
- d) Research hasn't shown a limit to the number of things people can remember.

9. There are three human factor loads. They vary in how many human resources they use. Which of the following lists the three in order from the most expensive to the least expensive?:

- a) Visual, cognitive, motor
- b) Action, memory, decision
- c) Cognitive, visual, motor
- d) Memory, decision, action

10. Which of the following is true of mental and conceptual models?:

- a) A mental model is the representation of what the user thinks, and a conceptual model is how the interface is represented on the technology device.
- b) A conceptual model is the representation of what the user thinks, and a mental model is how the interface is represented on the technology device.
- c) They are the same thing.
- d) A mental model is what you design in your prototype and a conceptual model is the final version after changes.

11. Which of the following does NOT describe what people do when they are under stress?:

- a) They work very slowly.
- b) They don't see things that are on the screen.
- c) They make a lot of mistakes.
- d) They tend to do the same things over and over even if they keep getting error messages.

12. When people are uncertain they turn to others to decide what to do. This is called...

- a) a mental model
- b) social validation
- c) reciprocity
- d) chromostereopsis

13. According to Robin Dunbar, what is the strong tie group size?:

- a) 50
- b) 100
- c) 150
- d) 500

14. Which of the following is NOT true of human-decision making?:

- a) It is mainly a conscious process.
- b) People will take an action to prevent losing something more than in anticipation of gain.
- c) People want a lot of choices.
- d) If you give people too many choices they won't choose anything at all.

Answer key

Self-evaluation

1. b

2. a

3. a

4. d

5. b

6. c

7. c

8. b

9. c

10. a

11. a

12. b

13. c

14. a

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