Evaluating User Interface Visibility

Evaluator Guide

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Introduction

The vis-UI-lise tool has been developed as part of research undertaken towards a PhD. Its aim is to be able systematically analyse the visibility of user interfaces as early as the development phase. Visibility is a dominant aspect of user interface usability. The complexity of the visual system means that it is not a simple matter of can the user 'see' it. The process in the visual system of moving from the detection of light by the retina to comprehension in the brain can go wrong for a number of reasons.

The vis-UI-lise tool helps to analyse where problems might occur. It addresses user interface elements that are:

- **Missing:** in other words they have no visible properties
- **Missed:** they are there but not perceived by the user
- **Misunderstood:** although seen they are not correctly understood

An example of this is the iPhone 6s. On its first 'app launcher' screen it has about 50 invisible functions. This has been exacerbated by the advent of force touch. Although such features are useful for 'power' users they can be traps for the less tech-savvy.

User interfaces continue to evolve with the increasing use of gestures and minimalist designs. The ability to understand visibility rigorously is becoming increasingly important. The vis-UI-lise Tool is aimed at user interface designers and human factors professionals. It allows a 'forensic' like analysis to be undertaken that helps in making predictions of potential problems. Its rigour takes time but the aim is to save time in the long run by highlighting potential problems early.

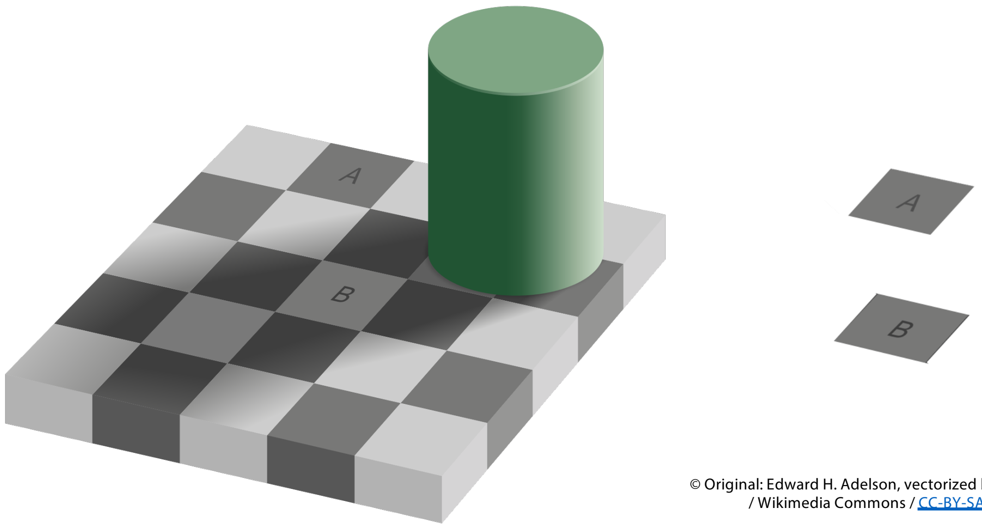
It is a prototype but one the hopefully adds value to existing development process and which through use can be improved. If you have any questions then please contact Ian Hosking e: imh29@cam.ac.uk

Background on Vision

It is easy to think of the human visual system as if the eyes are a pair of cameras that are projecting moving images into the brain. However if we tilt are head from side to side the image in our mind remains stable and level. If this was a simple camera image it would wobble as we move our head. Indeed if we turn our head upside down the horizon remains the right way up. This simple demonstration shows that there is a not a simple relationship between the image detected by the retina and the one we have in our mind.

If we consider the retina itself it only has high acuity imaging in a small central region, the peripheral area is lower acuity and only detects black and white. However the image in our mind is a seamless, colour representation of the world. Indeed the gap caused by the blindspot in the retina is 'filled' in by the brain. 3D representation is only partially provided by the presence of two eyes providing binocular vision. The rest is from monocular cues. The brain is able to integrate this information to provide a continuous, seamless and stable representation of the world to enable us to interact with it. Much of this comes top-down with the brain driven by what we attend to as we go about our daily lives.

It is more a case of 'believing is seeing' than 'seeing is believing' as our goals and prior knowledge influence what we perceive. This works effectively for most of the time but can break down. Examples of this are deliberate visual illusions where the mind it 'tricked' into seeing something that is not 'true'. While visual illusions are fun, such a breakdown when we are interacting with the world is not desirable, particularly in safety critical situations.



Checker shadow illusion - Adelson 1995

The image on the right is extracted from the one of the left. Without the shadow and checker surround you see that they are in fact identical.

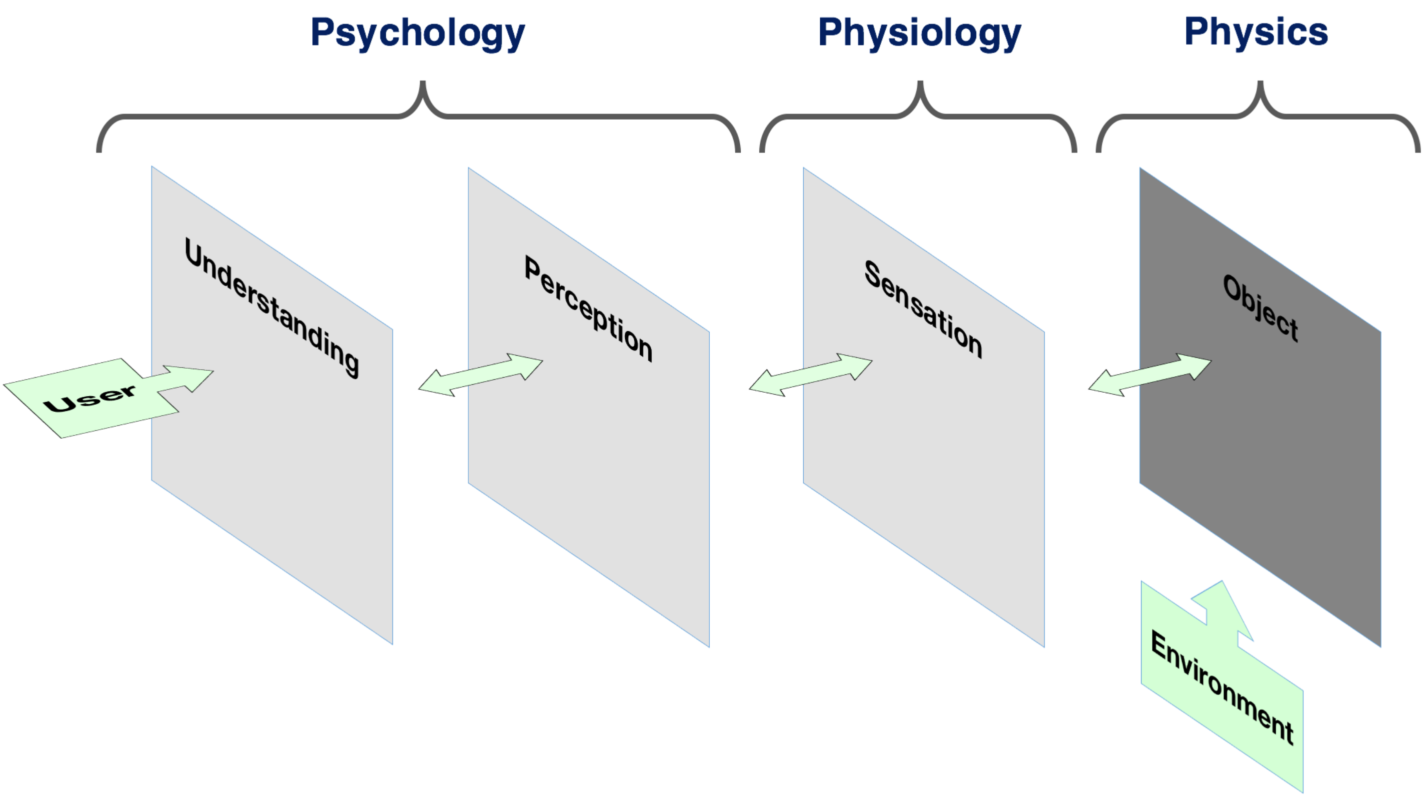
vis-UI-lise Framework 1

It is possible to understand the visual system in terms of three key areas namely:

- Physics: concerns the fundamentals of light and how it interacts with objects
- Physiology: concerns how the eye receives the light and turns it into signals that are transmitted to the brain
- Psychology: concerns how the brain takes these signals and interprets them to help understand what is in the world

It should be noted that all models are flawed and a simplification of what really happens. However this models helps to explain how the representation of the world in our minds is built up and how it can fail or be fooled.

The key here is that visibility is understood not just as exceeding a signal detection threshold but that it has to cross a perceptual threshold to be perceived. It is possible for objects to be detected and not perceived. For example in the case of inattentional or change blindness where the mind does notice things that the eye has detected.



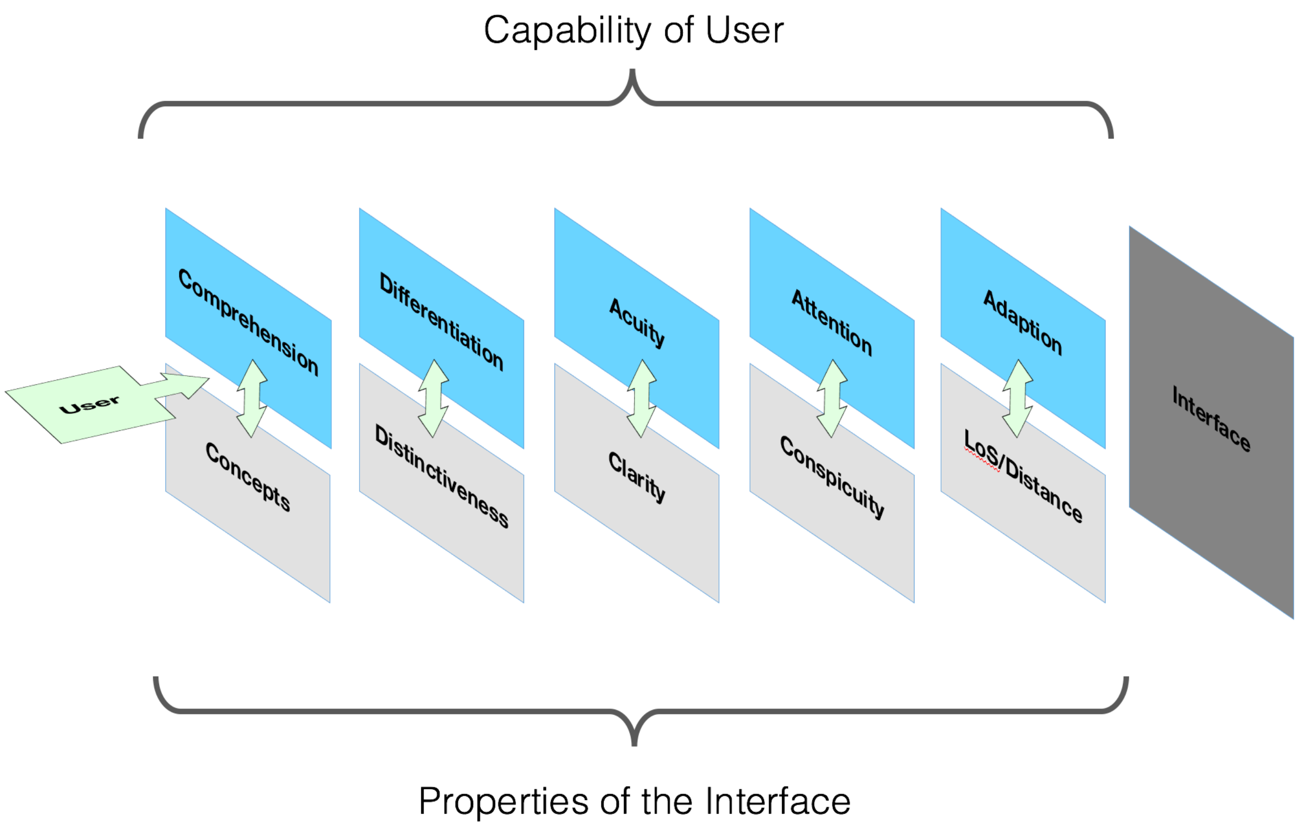
Based on: Green, M. et al., 2008. *Forensic Vision with Application to Highway Safety* 3rd ed., Tucson: Lawyers & Judges Publishing Company.

vis-UI-lise Framework 2

The framework can be seen as understanding how the capability of users maps to the properties of a user interface (see the diagram below). When the properties of the interface are too demanding on the user then it is likely that they they will not correctly perceive what the designer intended. A simple example is if a user interface element is too small or low contrast the user will not detect it. The layers of the model can been seen as a series of hurdles to get through. However in reality the layers interact dynamically (known as perceptual exploration).

Considering the layers from the left to right as follows:

- **Line of sight/distance:** at a basic level, is the user able to get line of sight and close enough to a user interface element. This is particularly a problem in car design where for example controls can be obscured by the steering wheel. Problems also occur when controls are at a distance a person can not focus on, in particular if they have to wear glasses with fixed focal length area(s). The ability of the user to focus effectively is called adaption.
- **Conspicuity:** this is the ability of the user interface to grab a user's attention at the appropriate time. This is particularly problematic if the interface control is in the periphery of a user's vision or undergoes a small change. Conspicuity maps to a users attention at a particular point in time and is influenced by the context, the user and their level of tiredness/arousal.



vis-UI-lise Framework 3

- **Clarity:** this relates to the properties of the user interface element that 'creates' sufficient signal to be detected. Key properties are size, shape, contrast and colour. These can be measured precisely if required, for example in safety critical systems. The clarity maps to a user's visual acuity. Visual acuity declines with age and leads to most people needing glasses to correct their vision from their mid-forties onwards for close work (hand-held distance). Also around 8% of the male population and less than 0.5% of the female population are colour blind so interfaces that rely on colour need to be reviewed carefully.
- **Distinctiveness:** a user interface object in isolation can be relatively clear. However in combination with similar objects, either present at the same time or elsewhere can cause confusion. A simple example of this is the letter 'S' and the number '5'. In different contexts such as shown below they can be confused. The first is a sequence of numbers the second is a word, however the third is a mixture of both for example in a password.

  12345 MISSED MI55ED

  The variety of different icons and language in modern user interfaces can lead to a lack of distinctiveness that means a user can not accurately differentiate similar but different user interface objects.
- **Concepts:** User interfaces usually really on the user of metaphors for example buttons on the screen represent physical buttons in the real world or files and folders represent paper equivalents. However users may not correctly comprehend the intended metaphor and become confused. When metaphors are commonly and consistently used then the user is more likely to comprehend, however uncommon, poorly chosen or inconsistently applied metaphors can cause confusion.

Tool Basics 1

The tool is based on a layered model that is described in the previous section. There are a number of key principles that go with this that are described below:

- Analysis is performed based on a series of **task steps** that enable the user to achieve a defined **goal** in a particular **environmental** context
- The state of the interface is consider **before** and **after (feedback)** an **action** is performed. Images are captured of these two states. Where the feedback is a sequence key additional parts of the sequence are captured.
- For a particular task the relevant user **interface elements/controls** are analysed.
- Three key aspects are considered of the captured interface states. These are:
  - **Function:** what the control does
  - **Operation:** how the control operates
  - **Feedback:** the feedback once the control is operated
- For the function, operation and feedback **five key visibility attributes** are considered. These are derived from the framework previously described (the language is simplified from the framework) and are as follows:
  - **Concepts:** can I comprehend what the concept (metaphor) is
  - **Focus:** can I focus on the user interface at a workable distance
  - **Conspicuity:** do the required user interface elements grab my attention at the appropriate time
  - **Clarity:** are the user interface elements of a sufficient size and contrast to be detected
  - **Differentiation:** are the user interface elements sufficiently distinctive from others that it may become confused with

Tool Basics 2

The **five key visibility attributes** are analyzed by considering a series of questions as follows:

Concepts

- **What** is the concept of the ‘function/operation/feedback’?
- **How** is the concept conveyed visually?
- Is it a **familiar** concept to the user? (check against real examples)
- How well is the concept **represented** & are there elements **missing**?
- Are there general **variations** of this concept that could cause **confusion**?

Focus

- Does the user have to move to get line of sight?
- Can the user focus on it? (bi or vari focal glasses)

Clarity

- What are the key distinguishing features? (these are listed individually and assessed for size and contrast)

Conspicuity

- Is it in the central visual field?
- Is it where the user would expect it to be?
- How many other related elements are there?
- Does it stands out against other elements/background?

Differentiation

- How different is it from other elements visible at the same time?
- How different is it from other elements visible at other times?
- Could it be confused with commonly used graphics/symbols that indicate something different?

Tool Basics 3

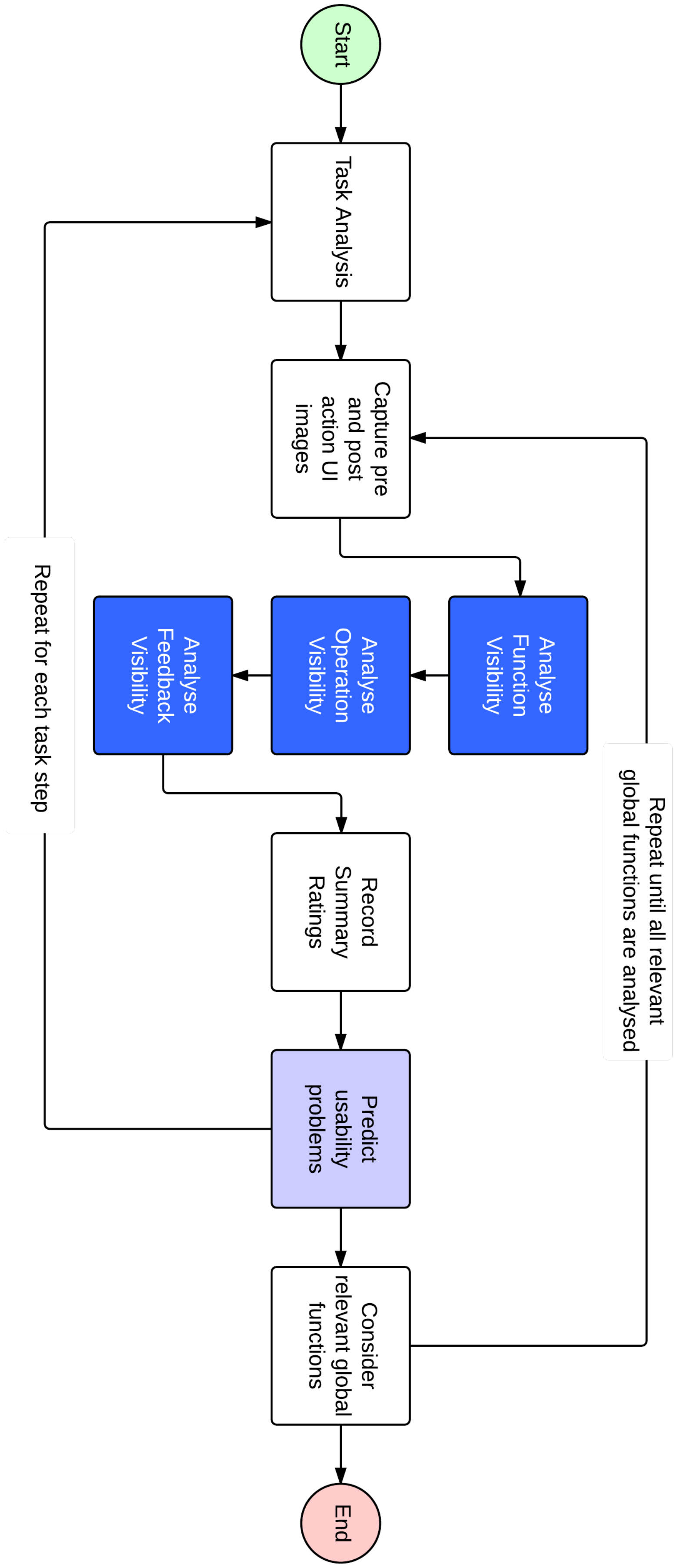
- In answering the **five key visibility attributes questions** a rating is recorded and the rationale (answer to the question) for the rating value. Rating values follow a traffic light system with the addition of black for controls that have no visible elements:

0. Invisible	No visibility and is highly likely to cause usability issues
1. Poor	An issue likely to contribute to some level of usability problem
2. Concerning	An issue that may lead to usability problems
3. Good	Unlikely to directly cause usability problems
No value	Value not yet set

- A rating is given for each question. The lowest (poorest) rating from the questions is used to set the **summary rating** on the **summary page**. The rating scales are tables in PowerPoint and each cell can be selected and the colour changed. When a function is automatic i.e. the user does not have to do anything to activate it the letters A U T O are placed in the 4 cells of the rating scale.

- After the visibility analysis is completed the output can be used to help make **predictions** about potential **usability problems.** Predictions are linked to the visibility attributes and given an estimate of **probability** and potential **impact**.

Analysis Process

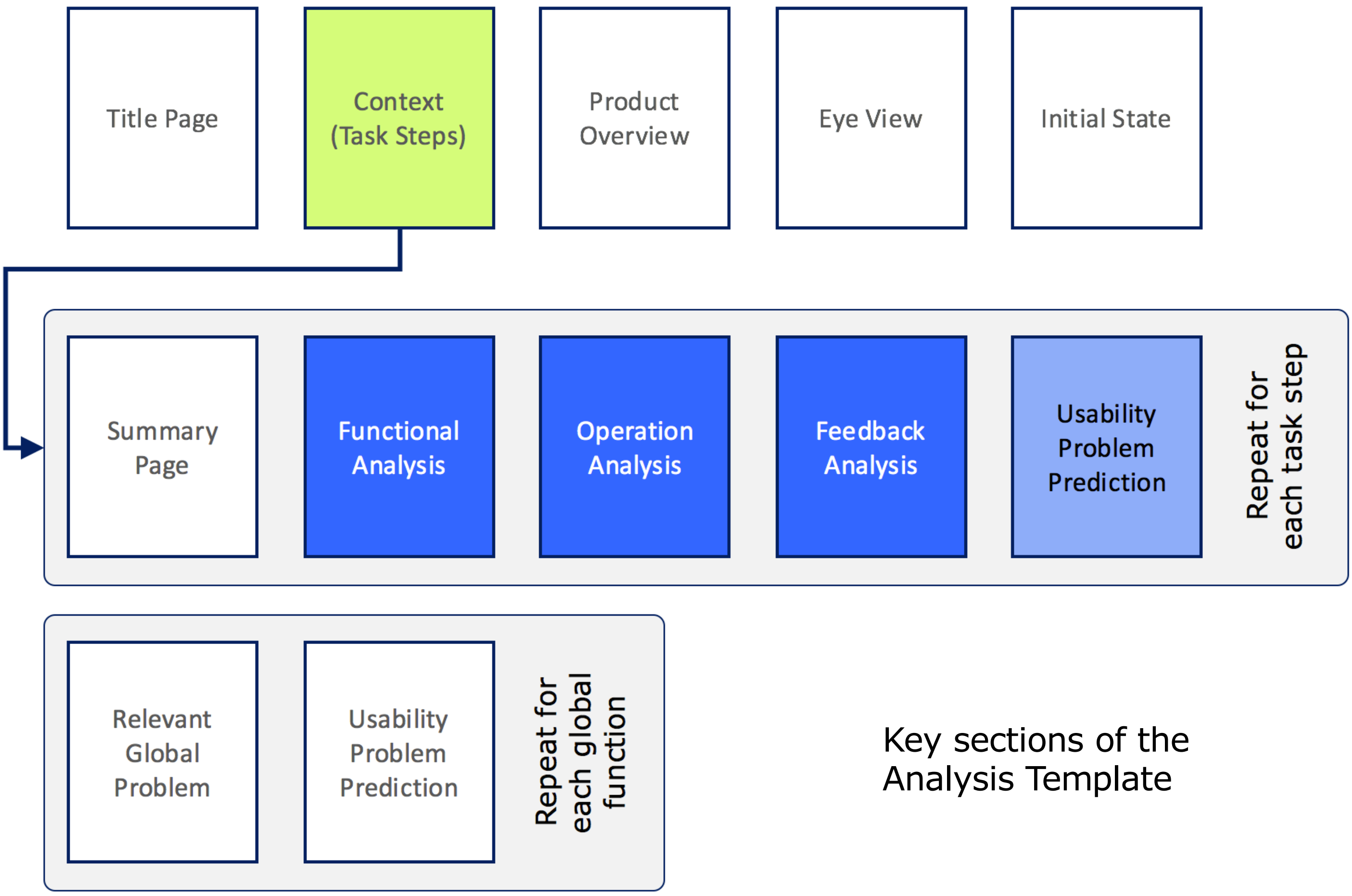


Analysis Template

The template has been created in Microsoft PowerPoint. This is because it is widely available and easy to adapt. In particular the template can be modified to suit the form factor of different interfaces. Landscape and portrait work well depending on the aspect ratio of the interface.

Rating scales have been created in tables so that individual cells can be selected and set to the colour according to the rating determined. The core of the activity consists (see previous page for a flow chart) of:

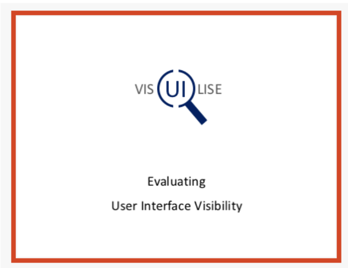
- Recording the before and after state of the user interface and placing these on the **summary page.** (The shape of these images should determine how the layout is modified as previously mentioned).
- Answering the attribute questions with a rating and rationale for each of the **five visibility attributes.** This is repeated for **'function'**, **'operation'** and **'feedback'**.
- The **summary ratings** are then recorded on the summary page based on the lowest rating on the attribute questions
- **Usability problem predictions** are then made based on this analysis.
- The is **repeated** for each task step
- Finally **relevant global functions** are considered



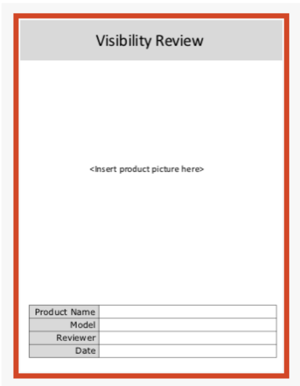
Key sections of the Analysis Template

The Toolkit

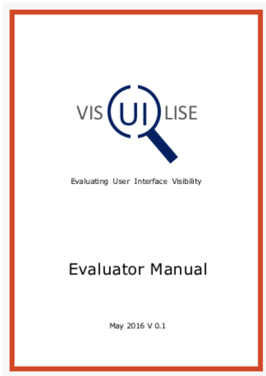
The Toolkit consists of the following elements shown below. It is recommended that the Introductory Presentation and Evaluator Guide are read before using the Analysis Template. The Example Analysis is a completed analysis to show what the final output should look like. Finally there is a quick reference card that can be printed doubled sided on A3 to help as a reminder during the analysis.



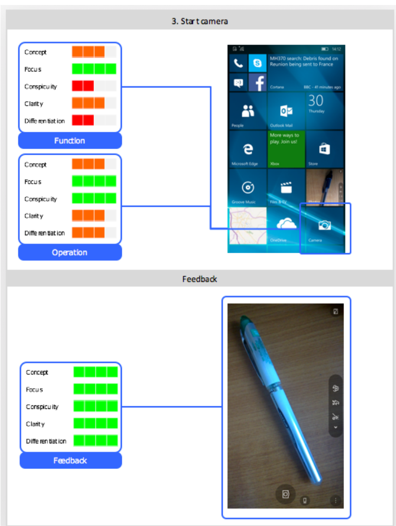
Introductory Presentation



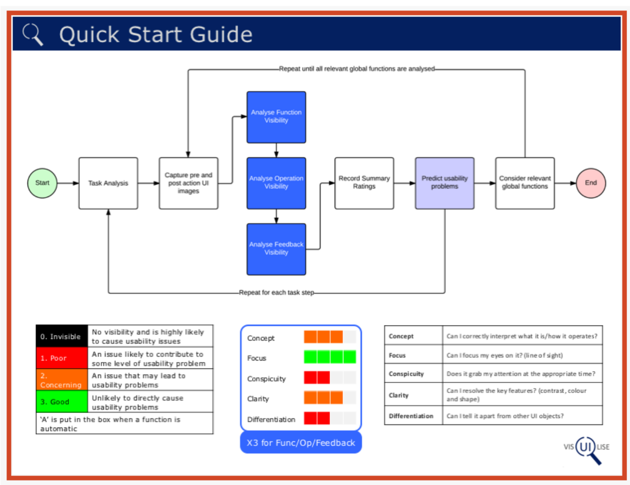
Analysis Template



Evaluator Guide (this document)



Example Analysis



Quick reference card

VISUILISE

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