Optical Authentication Features: User Analysis with Design in Mind

Banknotes today incorporate a multitude of security features to protect against counterfeiting, with such features ranging between levels 1-4 on the security scale – overt Level 1 features, machine readable Level 2 features, covert Level 3 central bank features and forensic Level 4 features.

The challenge for the banknote design team is not only knowing methods to prevent counterfeiting but also deciding which security features to use, particularly those classified as Level 1, to ensure end users such as the public or cashiers use them as intended.

To achieve this, they need an understanding of how users perceive and use Level 1 features and how they react to them. It is important that design teams comprehend the cognitive perception of such features – which ones draw a user’s attention, which they like and why, which they actually use and, conversely, which they do not.

Research by Hans De Heij

Hans de Heij of De Nederlandsche Bank has been working in this field for a number of years and, at the recent Optical Document Security conference in San Francisco, gave a presentation on some of his work regarding how the public perceive and use security features, and how this information could be utilised in the design of banknotes.

According to De Heij’s research, there are two aspects to banknote design in relation to overt features. First, there is User Centred Design and second, Technology Driven Design. His opinion is that this balance is distorted in favour of technology when, in fact, it should be biased towards users.

This is an important differentiation and fundamental in his research to understand how overt features are used, or indeed are not used, and subsequently how they should be chosen and designed.

To carry out his studies, De Heij used two models developed from public perception research to better understand how people use banknotes.

The ‘Coaster Model’ (fundamental and guarding function), which examines user functions from two aspects:

- The user interface (UIF): people recognising the note value, handling the note, checking its authenticity and receiving a communication (eg. the device moved as it should);
- The user experience (UXF): identifying (recognising) the banknote, judging its aesthetics, having confidence in it and reacting to the main image.

UXFs are generally of interest when there is a new banknote, whereas UIFs usually apply to known banknotes in use.

The 4M model (see Figure 1), which is based on how the brain perceives the banknote. For M1 the user pays no attention at all, M2 users pay attention to a single feature. M3 users pay attention to the complete banknote and maybe compares it with another, and M4 users give dedicated attention, for example if they read a central bank banknote educational leaflet.

As there are 10 User Functions (UIF is divided into four categories and UXF has six) and four perceptive situations (4M model), that enables 40 combinations of user functions and perceptive situations. However, it has been found that most people are in ‘denomination mode’, where they will have a quick look at the complete banknote (ie. they check the denomination and review the full banknote).

The world has changed

Having used both the Coaster and 4M models for his research, De Heij’s conclusions revealed that people do have confidence in their banknotes, and that they feel they do not have to check the authenticity of banknotes as they believe that:

- Banknotes obtained from ATMs are genuine;
- Retailers check banknote authenticity before issuing them to customers, and
- If they receive change, it is in low denomination notes which are not usually counterfeited;

Moreover, in general people do not want to bother checking banknotes. It can therefore be suggested that De Heij’s opinion is accurate, that banknotes are considered to be of a Technology Driven Design, rather than a User Centred Design. At least, that is the public perception.

Supporting De Heij’s conclusions are annual public perception ‘confidence in the currency’ checks by both the Bank of Canada and De Nederlandsche Bank from 2004 to 2015. Both countries had a virtually unchanged confidence level over the whole period, despite the fact that Canada experienced very high levels of counterfeiting from 2002-2007.

Another analysis from 2005 to 2015 on the use of banknote authenticating tools by retailers in the Netherlands concluded three significant facts:

- Use of ultraviolet light authentication has decreased, with 35% usage in 2007 but only 24% in 2015;
- Cash handlers using only their human senses (rather than hand-held authenticating devices) decreased from 54% in 2005 to 20% in 2015;
- Cash handlers using an automatic device has risen from 8% in 2005 to 65% in 2015.

These facts support De Heij’s findings, suggesting that reliable banknote authenticity checks are being implemented by retail and bank cashiers, resulting in an apparent reduced requirement for the public to do the same.

An attitude survey carried out in both 2013 and 2015 in the Netherlands regarding people self-checking their banknotes involved just over 1,000 people. In 2013, when participants were asked whether they had checked one or more banknotes during the past five years, 62% of participants did not perform a self-check. This was repeated in 2015. In 2013, 53% said they did not expect their behaviour to change. The results of the surveys confirm that the public are relying on the technology used by retailers and banks to issue authentic banknotes, rather than performing a self-check themselves. Consequently, this suggests the public have moved away from the User Interface (UIF) aspect to the User Experience (UXF) aspect as detailed in the Coaster model previously, explained in figure 2.

![Figure 1: How the brain perceives banknotes.](image)

![Figure 2: Shift in thinking from User Interface to User Experience.](image)
denomination number \( \text{(SPARJ® Origin)} \) in the €5 and €10 banknotes.

The ECB conducted a major publicity campaign for the introduction of both notes, yet only 1% said they noticed the watermark, 0% the hologram and 1% the emerald number, but 53% had noticed that the general colour of the banknote had changed.

Referring back to the attitude surveys carried out in 2013 and 2015, respondents were also asked about their knowledge of authentication features (see figure 3). It was found that respondents' knowledge of the banknote's security features had decreased between 2013 and 2015.

The watermark remains the best known banknote security feature, followed by the hologram. The security thread was a distant third at 14%, with the prominent emerald denomination in optically variable ink only being acknowledged by 4% (3% colour shift and 1% rolling bar).

Results from similar public perception surveys indicate that the main chosen overt feature should catch the eye of the user, drawing their focus, and if deemed to be questionable, leads the user to make further checks of other overt features included in the banknote. It was also suggested that overt security features should be aligned horizontally and preferably be a similar colour, whilst the entire banknote series should have similar designs to aid recognition.

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**Perception or attitude surveys can be a powerful tool to assist banknote designers with identifying suitable security features to include in their designs. They can help identify features which will either be used to great effect as a public recognition feature, or will in fact not be used in the anticipated way.

Of course, how the public use banknotes can vary dramatically from one country to another, and there is no “one banknote fits all” philosophy for banknote designers to use. It is therefore important that designers understand the cash cycle within their country, to know how banknotes are handled, thus ensuring that new banknote designs are accepted once issued and, most importantly, that confidence in the currency is maintained or even increased.