Predicting future banknote designs
By a use-centered approach

Dr. Hans de Heij
De Nederlandsche Bank NV
Amsterdam

Managers know: Make the right decision and make the decision right. In designer’s language: find the right problem and find the right solution. So, what is the right problem in case of the design of future banknotes? And subsequently, where should central banks find the right solution?

Authentication has been an important driver for new banknote designs. Understandable, as there have been three major threats in the history of banknotes, respectively the introduction of photography (around 1850), the rise of offset printing (around 1920) and the Digital Revolution (around 1980). Threats all caused by innovations within graphic reproduction techniques. However, nowadays central banks don’t face such a technical threat, but a usage threat.

Still, banknote design is characterised by a technology-driven approach instead of a use-centered one, which puts the user in front.

Three models are introduced to underpin the trend towards use-centered banknote designs:

**Double Diamond Model**

**Pyramid-Model**

**Upid-Model**

**Double Diamond Model**
Finding the right problem and find the right solution represent the two diamonds of the Double Diamond Model, shown in Figure 1. Both activities first diverge and subsequently converge. Furthermore, both activities have an analytical and a synthesis phase. The central bank is responsible for finding the right design problem, while the banknote designer is responsible for finding the right solution. To support this process the central bank may appoint a knowledgeable banknote designer manager, who start in the first diamond by questioning the problem of a new banknote design and will expand the scope of the problem by focussing on the different usage situations of banknotes.

Then the model converges towards a single problem statement, laid down in a Programme of Requirements. The banknote designer operates in the second diamond of the solution activity, also characterised by a phase of diverging before converging and delivering a proposal for a banknote design.

In 2007, Buxton summarised this process by ‘Getting the design right and the right design’.

**Payment methods and banknotes**
When people make a payment, they use a product like a banknote or a bank card, known as a payment instrument. When you would ask them, what is the function of the banknote or card, people tend to answer with: a means of payment. A wider understanding of a means of payment is a payment method, and Figure 2 provides an overview. With a payment instrument a user has access to a payment channel; a bank card provides access to a bank account and an ATM is part of the payment channel ‘banknotes’. On its turn, a payment channel is part of a payment system, such as non-cash and cash. Non-cash is wider than digital payments, as it includes also coupons, tokens and - still - cheques. In the past there was only cash, but nowadays people have a choice when they want to make a payment. To make this choice they have user criteria, based on user needs. What are these user needs?

**Pyramid-Model**
To answer this question, a lead is provided by the well-known theory of Maslow (1943) on the hierarchy of human needs. Originally Maslow discriminated six levels, which are often reduced to the following three: 1) basic needs, 2) psychological needs and 3) self-actualisation needs. Filling Maslow’s pyramid with the user needs of any payment method, results in the Pyramid-Model as shown in Figure 3. The depicted user needs are based on studies of user behaviour concerning payment methods. The first studies reported on descriptive profiles of credit card users (e.g. Etzel, 1968). One of the first to publish a list of attributes, characteristics that determine the user’s preference for a consumer payment system, is Hirschman (1982). A Dutch study on payment behavior by van der Horst and Cruysen (2016) delivers a ranking of seven attributes: fast (1), safe (2), easy (3), cheap (4), control of expenses (5), provides privacy (6) and well-accepted (7). A study done to consumer preferences within the Euro Area has been reported by Esselink and Hernández (2017), discriminating user preferences between cash and bankcards. What is striking about these studies is that there is no common
## User Interface Functions (UIFs)

The main user function of a banknote is recognising value [UIF 1]. Searching for a banknote in their wallet, people are first of all interested in their value. Also, when they receive a banknote as change, people’s first interest is if the correct denominations are offered. Subsequently, people will take the banknote, arriving at the second function in this category, named handling [UIF 2]. People use banknotes to pay each other and not for authenticity self-checks, something central banks sometimes seem to forget. Therefore user functions like value recognition [UIF 1] and handling [UIF 2] are more relevant to the user than checking authenticity [UIF 3]. Still, people should be able to do an authenticity self-check, in case they do not trust a banknote at offer. People do want to know what the themes, images and features displayed on a banknote represent [UIF 4]. User Interface Functions are the basic user functions of a banknote and have to be fulfilled; if not, the usability score of the note will be low. For the euro banknotes, in 2013, the unweighted score came out on 6.4 on a scale from 1 to 10, obviously room to improve.

## User Experience Functions (UXFs)

The first UXF is recognising identity: people are interested in their own banknotes, not that much in others. Second, within a fraction of time, people have their judgement ready on the aesthetics. They either find the banknote beautiful or ugly. For this reason judging aesthetics is listed as UXF 2. Whether a new design looks like a valuable banknote or a cheap coupon is a matter of keeping confidence, function UXF 3. Furthermore, the main image of the new design is noticed instantly, is it a portrait, a bird or a tower? Reacting on the main image is therefore one more user experience function [UXF 4]. Two upcoming User Experience Functions are positioned at the bottom rows.

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### Payment methods

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*Figure 2.* Overview of payment methods, divided in payment systems, payment channels and payment instruments.

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"...terminology yet. Concepts like security, safe, safety, resilience and reliability are close to each other, yet different. Several studies report on the greatest determinant of a payment system, like convenience for the Danes [Jacobsen and Nielsen, 2011] and ease of use for the Canadians [Arango et al., 2012]. At the bottom of the Pyramid-Model the basic user needs are depicted. In the center there is the user need that the payment instrument should be easy to use. Other user needs refer to attributes of the payment method, like access, safety and settlement time. In the center of the middle section of the Pyramid-Model there is the user need that the payment instrument should be nice to have, surrounded by user needs referring to the payment system, like privacy, risk of loss and overview of expenses. In the top of the pyramid is ‘piece of mind’, people want to be happy with their means of payment; above all, it should be hassle free."

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### Upid-Model

So, user needs of a payment instrument are divided in ‘easy to use’ and ‘nice to have’, respectively a basic and a psychological user need. Easy to use and nice to have are container concepts and can be divided into more specific user needs with the help of the introduction of user functions. The Upid-Model divides ‘easy to use’ and ‘nice to have’ in respectively four User Interface Functions (UIFs) and six User Experience Functions (UXFs). The terms User Interface Functions and User Experience Functions are derived from the developments within the information technology, especially by the domain of interaction design of screens.
People expect their banknotes to be ‘green’ [UXF 5] and expect that they can check a banknote by using a smartphone or by any other linkage to information technology [UXF 6]. When a banknote designer does not pay attention to any of the User Experience Functions people may still be able to use a banknote for a payment. However, when the psychological user needs are also fulfilled, the design will receive a high experience score.

**Analyzing present banknote designs**

The daily use of banknotes is typically driven by withdrawals from ATMs, wallet use and payments to a retailer or banknote acceptor. Analyses of the User Interface Functions starts with value recognition (UIF 1) and handling (UIF 2). Both can be improved by reducing the number of denominations. Instead of six or seven denominations, central banks may issue three, enough for daily payments, as known from Japan and the United Kingdom. The note-coin boundary will be the lowest ATM note. When the central bank opts for extending the payment denominations with a saving denomination, a high denomination, the number of denominations could be brought to four. To prevent misuse by criminals, such a saving denomination can only be handed in at a controlled environment like a bank. Therefore these notes receive a larger format to prevent its use in machines dedicated to daily payments.

Value recognition is further improved by introducing main images [UXF 4] from different image categories. A series should not depict only portraits, or only buildings or birds. Such images may be switched without being noticed and don’t contribute to instant value recognition. Instead, the individual notes of a series should depict a main image from different image categories, as is the case in the recent Norwegian series ‘The Sea’ (first issue in 2017). Handling can be further improved by adaption of size and orientation. Today, people may store some banknotes in the etuis for their smartphones or in card cases. Usually they don’t keep any coins there. These new handling habits will have consequences for the design of future banknotes. Banknote sizes, folded or unfolded, could be adapted to the ‘credit card format’ of 86 mm x 54 mm. A banknote is more and more used as a fall back, for example in case a digital payment instrument does not work. In case of wallet use, banknotes are stored horizontally, which is the same orientation of the notes withdrawn from an ATM. As the public does not pay attention to the reverse of a banknote, this horizontal front is the public side, implying that the reverse is the retail side. Retailers keep banknotes often in a vertical position in their cash drawers. A vertical orientation is also required when a banknote is inserted in a payment terminal accepting banknotes, a user situation which will occur more often in the future.

Nowadays, almost all currencies have a single note height. Exceptions, among some others, are the euro and the British pound. A single note height of 72 mm, the height of the euro 20, is to the Dutch the most practical one. To assist the blind, the payback denominations should receive an increasing length increment of respectively 7 mm and 8 mm.

A shift is expected in future banknote designs from checking authenticity [UIF 3] to retaining confidence [UXF 3], from a focus on public authenticity features to confidence features. Public features were introduced in the 1980s, to involve the public as a ‘first line of defence’ against the spread of counterfeited banknotes. However, the world has changed and to date people do not see any need to execute an authenticity self-check. And they are right. Banknotes withdrawn from an ATM are genuine and do not have to be verified. Furthermore, retailers check incoming banknotes with devices, something that the public sees. And, the probability that the public will receive a low counterfeited denomination is practically zero. So, why should the public do an authenticity check?
Such a check is only required on special occasions, like in case of case of special festivities or a purchase from a private person on the internet. In such cases people may use an app on their smart phone to check a banknote. The conclusion is that people don’t want to be bothered any longer by authenticity self-checks. Studies in Canada and the Netherlands show that people have a high, stable and increasing trust in banknotes. This implies introduction of public confidence features instead of public security features. Furthermore, public authenticity features should be intuitive and self-explaining. For security features, the focus of central banks should shift to features for the retailer; switch the present level 1 and 2 in retail features (level 1) and public features (level 2).

Within the User Experience Functions the focus of central banks is usually on the main image [UXF 4], on what is on the banknote? First, as said above, value recognition will be improved when the main images within a series of banknotes will be based on different image categories. Second, the search for a main image should be triggered by an identity description [UXF 1]. Instead of backward symbolism, such as historical persons or building, the trend will be to select images based on forward symbolism. Two examples here. The Swedish central bank replaced the portraits of historical persons by images of people which have a greater appeal to the Swedes, like movie star Greta Garbo. The Bank of Canada reported that Canadians expect their new banknotes to serve ‘today and the years to come’. An important user function in the near future will be green banknotes, as people will expect more than today that their payment instruments are sustainable [UXF 5]. Studies on Life Cycle Analysis show that synthetic banknotes are more sustainable than cotton. Finally, future banknotes will have to interact much more with Information Technology, especially with smart phones. An example here is a QR-code, which would link a banknote directly to the website of the central bank, as was done first on a Nigerian banknote of 100 naira, issued in 2014. Also, the banknote number may receive a new role, as banknotes may be verified online, by real time number equation. However, the banknote user’s privacy will be respected, the user will remain anonymous. To improve the machine readability, the banknote number can be replaced by a barcode type.

**From user functions to design requirements**

The next step for the central bank’s design manager is to transform the trends observed above into design requirements. In three stages design requirements are derived from user functions by abiding questions about ‘what’ and ‘how’, illustrated in Figure 5. The first step is the transition from user functions into functional requirements, which are, in turn, transformed into user requirements and subsequently into design requirements. Figure 5 provides an example for the user function of ‘retaining confidence’, UXF 3 (what 1). A holographic stripe is the most eye-catching public feature of new banknotes, such as Canada, United Kingdom and the Euro Area; studies on the euro showed that such a stripe contributes more than other features to confidence. The next step is the formulation of the functional requirement, for example ‘confidence stripe’ (how 1), which is in this example a wide glossy stripe (what 2). Collected user preferences on such stripes are input for the design requirements (how 2), for example that the stripe should match with the banknote’s value.

**Concluding**

Banknote design management should invest in user needs. When cash is no longer an attractive payment instrument, banknotes will disappear. User needs will lead to other design requirements as applied today. Furthermore, banknote designers should focus first of all on the User Interface Functions, instead of spending their creativity to User Experience Functions like connecting to a main image.

**Figure 4.** An example of use-centered design of banknotes (By Lien, 2015). These innovative concepts are prepared for an imaginary currency: Mako (Money of Area 5). Although they look different, the notes are immediately recognizable as banknotes. These designs include a confidence stripe as a result of the shift of UXF 3 (UXF 3).

**Figure 5.** Schematic representation of the transition of user functions to design requirements, including an example of the user function ‘retaining confidence’ (UXF 3). To arrive at design requirements, functional requirements should be identified first, followed by user requirements.

*The user expects that complex patterns are there for the counterfeiter and do not have to be checked by the user.*