The Pyramid–Model and other methodological tools for the underpinning of use-centered banknote design

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Banknote design becomes more and more challenging to navigate. Methodological tools will assist both the banknote designer and the banknote design manager. This article provides an overview of the available models and schemes to underpin a use-centered banknote design process. The Pyramid–Model is the latest model developed and addresses the user needs of any payment method, cash or digital. The Pyramid–Model embeds the existing Upid–Model. Together these two models provide a complete view on the usage of a payment instrument like a banknote. Above all, the Pyramid–Model explains that paying each other is for most people a dissatisfier. People expect payment transactions to be smooth and get irritated when this is not the case. Unfortunately, user friendly banknote designs will not bend the trend from cash to digital payments.

Payment methods and banknotes
In the past there was only cash, but nowadays people have a choice when they want to make a payment, a choice ranging from coins and banknotes to online banking instruments like a smartphone. An overview of different payment methods is provided in Figure 1, a breakdown of payment systems which helps to understand the current competition between payment instruments, one of them being banknotes. With a payment instrument, a user has access to a payment channel. For example, a debit card provides access to a bank account and similar, an ATM provides access to 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 also includes coupons, tokens and – still – cheques.

The terminology introduced clarifies the well-known strategy of companies of ‘shifting payment channels’. An example is the Dutch railroads, the NS. In the past, travelers bought their tickets at a counter. Around 1985, the NS offered their clients a cash payment automate. The next transition was to online banking, around 1995. And today, almost all travelers use a form of automatic direct debiting.

<table>
<thead>
<tr>
<th>Payment methods</th>
<th>Payment channels</th>
<th>Payment instruments</th>
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<tbody>
<tr>
<td>Non-cash</td>
<td>Bank account</td>
<td>Online banking (e.g., smart phone)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Automatic) direct debiting</td>
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<tr>
<td></td>
<td></td>
<td>Debit cards</td>
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<td>Paper forms</td>
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<tr>
<td></td>
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<td>Online purses</td>
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<td>Cash</td>
<td>Infrastructure coins</td>
<td>Coin denominations</td>
</tr>
<tr>
<td></td>
<td>Infrastructure banknotes</td>
<td>Banknote denominations</td>
</tr>
</tbody>
</table>

*Figure 1.*
Overview of payment methods, divided into payment systems, payment channels and payment instruments.

Fast, easy and safe
The provided overview in Figure 1 clarifies that the banknote designer may design banknotes, a payment instrument, but cannot influence the payment channel or system. For banknote designers it is frustrating that people do not opt for beautiful banknotes, but for a payment system which is fast, easy and safe (Van der Cruijksen and Van der Horst, 2016), as will be elaborated on under
the heading Pyramid-Model. Paying with banknotes is slow, a cash transaction takes about 20 seconds, while a contactless payment with a debit card takes less than 5 seconds. However, even a perfectly designed banknote will not be able to convince people to opt for banknotes. When it comes to ‘easy’, banknotes also lose territory. A cash transaction will involve several payment instruments, some coin and banknote denominations, while for a contactless payment only one payment instrument is needed, a bank card. Nevertheless, easy is influenced by the banknote usage environment, such as uncomfortable access to ATMs (far, out of order, not clean), poor acceptance by retailers (PIN only) and a poor image (criminal money, money for elderly). Finally, safety, which is not so much an issue for the general public, but is the major concern of retailers. A 2018-study reports that Dutch retailers prefer cards above cash. They tell that cash deposits are too much of a hassle and safety issues like robbery, theft and counterfeits are their second concern (DNBulletin, 2018).

The user preference for fast, easy and safe payment methods is unfortunately beyond the reach of the banknote designer. Within reach is the usability of the banknotes itself. Indeed, the usability of banknote designs can be improved, illustrated by a score of 6.4 measured in 2015 for euro banknotes on a scale from 1 to 10 (De Heij, 2015).

Managers know: Make the right decision and make the decision right. In designer’s language: find the right problem and find the right solution. The right solution should be based on user needs, on which the first studies appeared in the 1960s, reporting on descriptive profiles of credit card users (e.g. Etzel, 1968). Studies on user preferences for cash followed much later, the first appearing at the time that cash payments at Points of Sale (PoS) started to decline, roughly around the Millennium change. A recent study by the European Central Bank, shown in Figure 2, provides an overview of user preferences for both cash and bank cards. This table shows that people find cards easier than cash.

<table>
<thead>
<tr>
<th>EURO AREA (2017)</th>
<th>Reasons to prefer (in %)</th>
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<tr>
<td>Payment methods</td>
<td>Cash</td>
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<tr>
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<td>Overview expenses</td>
<td>38</td>
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<td>Acceptance</td>
<td>13</td>
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Figure 2. Overview of responses of citizens within the euro area on the question was: “For you personally, what are the two most important advantages of cash/cards for payments? Cash cards are…” (Esselin and Hernández, 2017).

Different levels of product development of tangible money
Cash is tangible money, known as coins and banknotes. This has grown so historically. Now that cash is being used less and less, the question is whether new banknotes have to be designed according to the templates of the previous banknote. If central banks would opt for more user friendly banknotes, their design policy should shift from a technology-driven banknote design policy towards a user-centered one. Such a change in design policy concerns product development on level I, the first of three different levels as explained in Figure 3. Because of the decline of cash, one may argue that it is about time for new concepts of tangible money, represented by level II. A third level is the most abstract one, representing theoretical concepts for paying each other tangible. To give an idea, such a concept could be based on divisible units, following a denomination scheme of 1, 3, 9, 27, 81 etc. (powers of three).

Double Diamond Model
Finding the right problem and finding the right solution are two essential phases for any type of product development and also for the level of new banknote designs. The Double Diamond Model represents these two steps, shown in Figure 4. Both activities first diverge and subsequently converge. Furthermore, both activities have an analytical and a synthesis phase. In 2007, Buxton summarised this process by ‘Getting the design right and the right design’.

In this article, product development of other types of tangible money, products on level II and III in Figure 4, are left for what they are; the focus is on banknote design, on level I. In this situation, 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 design manager. This person will start in the first diamond, questioning the problem of a new
banknote design and will extend this analytic phase with studies on different usage situations of banknotes. Subsequently, the model converges towards a single problem statement, laid down in a Programme of Requirements. The banknote designer typically operates in the second diamond, which is also characterised by a phase of diverging before the converging phase of delivering a proposal for a new banknote design.

**Usage threat**

So, what is today's main problem of banknote design? My answer is a usage threat instead of a new counterfeit threat. It is understandable that central banks (still) focus on technology of security features, as there have been three major counterfeit 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). All these threats were caused by innovations within graphic reproduction techniques. However, today there is no new reproduction threat, but the problem is that users have started to avoid cash payments. Arriving at the second diamond, the question is: Where should the central bank find the right design solution? As people avoid more-and-more cash payments, a use-centered design policy is the way to go. Essential for such an approach is understanding of usage behaviour and perception.

**Venn diagram: users - banknotes - payment situations**

In general, three domains are recognised to characterise user behaviour: the people (1), the product (2) and the usage environment (3). In case of banknotes these are respectively users (1), banknotes (2) and payment situations (3). These three study domains are represented in Figure 5 by different colours, respectively blue, green and red, an example of a Venn diagram. One of its added values is that relationships between the three domains become visible by a new colour. In case, the relationship between users and banknotes becomes blueish green and the relationship between banknotes and payment situation colours brown orange. The centre, where all three areas overlap, becomes dark brown, representing users, banknotes and payment situations.

Within the presented Venn diagram two models are indicated, respectively the Pyramid-Model and the Upid-Model. Both models will be explained in the following. Understanding the centre of the Venn diagram will probably deliver the richest insights in user behaviour with banknotes, an area more-or-less unexplored.

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**Figure 3.**

Three levels of the product development of tangible money, illustrated by some examples (images of examples on the left: public domain, images of examples on the right by author).

The banknote designer and the banknote design manager operate on product development level I.

Figure 5.
Venn diagram with three variables: people (blue) use a banknote (light green) in a specific payment situation (red). Studies may focus on the relationships between users and banknote (blueish green), between banknote and payment situation (brown orange) and between users, banknotes and payment situations (the center, dark brown).

Pyramid-Model
The first model to be introduced is the Pyramid-Model, which lists the user needs of any payment method and is therefore located in the blue area of Figure 5. This model provides insights into the preferences of a user for a certain payment method, in case, will the user opt for cash?

The framework of Pyramid-Model is based on the hierarchy of human needs, the well-known theory of Maslow (1943), a general approach. Originally, Maslow distinguished between six levels, which are often reduced to the following three: basic needs (1), psychological needs (2) and self-actualisation needs (3). Filling Maslow’s pyramid with the user needs of any payment method, results in the Pyramid-Model, shown in Figure 6. The depicted user needs are based on several available studies on user behaviour concerning payment methods.

One of the first to publish on this matter is Hirschman, presenting in 1982 a list of attributes for a consumer payment system. Attributes are characteristics that determine the user needs or user’s
preferences, which is less precise than a user requirement as will be explained further on (Figure 9). Later, a Dutch study on payment behavior by Cruyssen and Van der Horst (2016), already cited above, delivers the following ranking of seven attributes: fast (1), safe (2), easy (3), cheap (4), control of expenses (5), provides privacy (6) and well-accepted (7). What is striking about these studies is the absence of a common terminology. 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 method, like convenience for the Danes (Jacobsen and Nielsen, 2011) and ease of use to the Canadians (Arango et al., 2012). A study on consumer preferences within the euro area is already reported above (Figure 2).

Basic user needs are presented at the bottom of the Pyramid-Model. 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 - not the instrument - like access, settlement time and safety. The middle section of the Pyramid-Model represents the psychological user needs. In the center of this area there is the user need that the payment instrument should be nice to have, which is surrounded by attributes all referring to the payment method, like privacy, risk of loss and overview of expenses. At the top of the pyramid is ‘peace of mind’, people want to be happy with their means of payment; above all - being a dissatisfier - a payment transaction should be hassle-free. After all, finishing a cash transaction nobody says: ‘Wow, this has been a beautiful cash transaction!’.
Upid-Model

The second model indicated in Figure 5 is the Upid-Model, the topic of my thesis (De Hei, 2017). The Pyramid-Model (Figure 6) divides user needs of a payment instrument into ‘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’ respectively into four User Interface Functions (UIFs) and six User Experience Functions (UXFs), listed in Figure 7. The terms User Interface Functions and User Experience Functions are derived from the developments within the information technology, especially in the domain of interaction design of screens.

User Interface Functions (UIFs)
The main user function of a banknote is recognising value (UIF 1). When searching for a banknote in their wallet, people are primarily interested in the banknote’s value. Also, when they receive a banknote as change, people’s first interest is if the correct denomination is on offer. Subsequently, people will take the banknote, named handling (UIF 2), the second function in this category. 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); nobody uses banknotes only because they are genuine. Still, people should be able to do an authenticity self-check, in case they do not trust a banknote offered. Finally, people do want to know what the themes, images and features displayed on a banknote represent, the user function of receiving the communication message (UIF 4).

The usability score of a banknote is the average public score of a banknote on these four User Interface Functions.

User Experience Functions (UXFs)
The first UXF is recognising identity; people are interested in their own banknotes, not that much in banknotes from others. Second, people make - very quickly - a judgement 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 retaining confidence, function UXF 3. Furthermore, the main image of the new design is noticed instantly, is it a portrait, a bird or a tower? Therefore, one more user experience function is connecting with the main image (UXF 4). Two upcoming User Experience Functions are positioned on the two bottom rows. People expect their banknotes to be ‘green’, labelled as expecting sustainability (UXF 5). People also expect that they their banknote can be linked to information technology (UXF 6), for example to check a banknote by using a smartphone.
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.

Wide foil stripes with transparent areas
The practical value of the Upid-Model is illustrated by an example. Figure 8 displays four contemporary banknotes, all equipped with a wide foil stripe with transparent areas. The wide foil on the euro 50 - issued in 2017 - was object of study on user perception in
designs may therefore carry a ‘confidence foil’ rather than an ‘authenticity foil’. The following explains how such an analysis of user behaviour may be translated to the user requirements for a new foil feature.

**Figure 8.**
Four examples of banknotes with a wide holographic stripe.

a) CAD 10/John A. Macdonald, part of the Frontier Series, issued in 2013.
b) GBP 10, featuring Jane Austen on the reverse, issued in 2017.
c) EUR 50/Renaissance, as part of the Europa Series, issued in 2017.
d) ASD 10/Andrew Barton (Banjo) Paterson, issued in 2017.

**From user functions to design**

Role of the central bank

<table>
<thead>
<tr>
<th>User functions</th>
<th>Functional requirements</th>
<th>User requirements</th>
<th>Design requirements</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What?</strong> Retaining confidence UXF 3</td>
<td><strong>How?</strong> Confidence strip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Silver, glossy strip</td>
<td>2) On the right side</td>
<td>3) Match with value</td>
<td>4) Complex patterns*</td>
<td>1) 20 mm wide</td>
</tr>
</tbody>
</table>

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

**Figure 9.**
Schematic representation of the derivation 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.
From user functions to design requirements
In general, a designer cannot do much with user needs and user functions. Designers are in need of more detailed information, known as design requirements, laid down in a Programme of Requirements. In three stages, design requirements are derived from user functions by abiding questions about 'what' and 'how', as explained in Figure 9. This figure includes the promised example of a confidence strip, which is part of the first question (what 1), the question of which user function will be addressed? While an authenticity strip would have been part of user function ‘checking authenticity’ (UIF 3), a confidence strip will be part of ‘retaining confidence’ (UXF 3). The next step is the formulation of the functional requirement, for example a ‘confidence strip’ (how 1). Collected user preferences on such strips are input for the user requirements (how 2), in this example a silver glossy strip, on the right side, corresponding with the note’s value and showing complex patterns. Subsequently the user requirements are transformed into design requirements (what 2), like a wide stripe is a 20 mm wide foil.

Concluding
Methodological tools will assist the banknote design manager to deliver user friendly banknote designs. Two related models have been introduced supporting a better understanding of the users of any payment method, the Pyramid-Model and the Upid-Model. By application of these two models, the design of a banknote is broken down into 10 user needs for the payment situation (Pyramid-Model) and 10 user functions of the payment instrument (Upid-Model). User requirements should be defined for both models. Subsequently, users should provide a positive score for each of the defined user requirements, for example at least 7 on a scale from 1 to 10. With the competition of digital payment instruments this seems to have become an impossible assignment for central banks developing new banknotes. People will avoid cash because other payment methods fulfill their user needs better, especially on transaction time, handling and safety. This problem will not be solved by the traditional approach of a new bank-note design. Therefore, instead of an upgraded set of coins and banknotes, central banks may start looking for alternative concepts of tangible money, building further on the user needs of back-up money, a means of payment which can be used when digital payment systems fail (product development on level II). However, in order to save what can be saved, the designers of a new banknote should first of all focus on the two main User Interface Functions (recognising value and handling), and less on User Experience Functions like connecting to a main image. Remember, people are not using a banknote because of its authenticity features.

References