Optical Security and Counterfeit Deterrence Techniques III

Volume 3973

PROCEEDINGS OF SPIE
SPIE—The International Society for Optical Engineering

Optical Security and Counterfeit Deterrence Techniques III

Rudolf L. van Renesse
Willem A. Vliegenthart
Chairs/Editors

27–28 January 2000
San Jose, California

Sponsored by
IS&T—The Society for Imaging Science and Technology
SPIE—The International Society for Optical Engineering

Published by
SPIE—The International Society for Optical Engineering

Volume 3973

Please use the following format to cite material from this book:

Author(s), "Title of paper," in *Optical Security and Counterfeit Deterrence Techniques III*, Rudolf L. van Renesse, Willem A. Vliegenthart, Editors, Proceedings of SPIE Vol. 3973, page numbers (2000).

ISSN 0277-786X
ISBN 0-8194-3591-0

Published by
SPIE—The International Society for Optical Engineering
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone 360/676-3290 (Pacific Time) • Fax 360/647-1445

Printed in the United States of America.

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Introduction

This third IS&T/SPIE Conference on Optical Security and Counterfeit Deterrence Techniques was preceded by those held in 1998 (SPIE Volume 3314) and 1996 (SPIE Volume 2659). Earlier related SPIE conferences were the 1990 Conference on Optical Security and Anticounterfeiting Systems in Los Angeles (SPIE Volume 1210) and the 1991 Conference on Holographic and Optical Security Systems in The Hague, Netherlands (SPIE Volume 1509), both of which were organized and chaired by William F. Fagan.

These conferences aim to bring together specialists from diverse disciplines, specialists dedicated to combat forgery, counterfeiting, and product piracy by developing new security technologies, policies, and approaches and by improving those in existence. This conference again offered numerous valuable scientific and technical papers that reported on the results of the ongoing research and experience gained in these fields. And, indeed, its purpose was expressed in the announcement and call for papers as follows:

The objective of this third two-day Conference on Document Security and Counterfeit Deterrence Techniques is to bring together researchers, manufacturers, and users of security devices and systems. This conference will review security policy and technologies, present papers on current advances in optical, optoelectronic, and electronic imaging security as well as survey novel photonic technologies for application in future security devices.

In this context it may be appropriate to mention that SPIE, being a scientific society, sets a few fair rules for acceptance of papers. We wish to explicitly draw attention here to a few of these rules:

- Only original material should be submitted.
- Commercial papers, descriptions of papers, with no research/development content, and papers where supporting data or a technical description cannot be given for proprietary reasons will not be accepted for presentation in this symposium.
- Abstracts should contain enough detail to clearly convey the approach and the results of the research.
- Government and company clearance to present and publish should be final at the time of submittal.

It is most unfortunate that there are authors who disregard these rules and submit papers with commercial content or wish to change their papers at a very late phase in order to omit details that they have come to regard as proprietary.

The two preceding conferences excelled particularly in papers on nanomanipulation of matter in order to create optically variable devices (OVDs) displaying unique optical effects. This nanosecurity is based on the complexity of nanostructures rather than on image complexity. The former potentially allows creating high-*security* features that can be easily inspected by the unaided eye, while the latter tends to result in security features that may be problematic from an ergonomic point of view. As expected, this significant tendency was continued at this third conference. Although others may rightfully emphasize other contributions, we would like to particularly mention the following authors in this respect: James M. Jonza (multilayer thin film structures), Franco Moia et al. (photo-polymerized liquid crystals), and René Staub et al. (self-referencing diffractive features).

Sometimes, new ideas seem to "hover in the air," and as a result, interrelated developments become published almost simultaneously. Fully in this fashion, a new point of the security compass is characterized by a number of papers at this third conference: the synergistic combination of security techniques. In particular the contributions of Jan van den Berg et al. (polymer substrates), Hans I. Bjelkhagen (Lippmann photographs), Bruce Hardwick et al. (polymer substrates), Roger W. Phillips et al. (holograms with interference films), Itsuo Takeuchi et al. (liquid crystals with diffractive properties), Wayne R. Tompkin et al. (diffractive optical codes for ID-card security), and Gary R. Wolpert (synergism of security features) are worth mentioning in this respect. Among others, these contributions discuss the implementation of diverse security features in polymer substrates, the combination of diffractive optically variable image devices (DOVIDs) with interference security image structures (ISISs), and the combination of OVDs with laser engraving techniques.

Apart from the above-mentioned contributions that together mark these most exciting trends in optical document security, and without dismissing any of the other contributions, each undeniably having their own specific merit, we wish to mention two other contributions that seem to deserve special attention. One contribution is by Ana Andrade, who discusses a systems approach to objectively assess the security value of DOVIDs by Multicriteria Decision Analysis. We would like to see this helpful approach extended to OVDs in general. Another contribution is by Jack Tchan, who treats a classification procedure of the production process of digital prints utilizing neural networks. The further development of this procedure may become helpful in the automatic classification of the speedily growing number of digifeits (digital counterfeits produced on DTP equipment).

It is anticipated that the next IS&T/SPIE Conference on Optical Security and Counterfeit Deterrence Techniques, to be held in the year 2002 in San Jose, will continue these trends in the ergonomic and synergistic aspects of document security.

Finally, we wish to express our gratitude to all conference committee members and all contributing authors for their invaluable contributions to this conference.

Rudolf L. van Renesse
Willem A. Vliegenthart

Contents

SESSION 1

Security Design

The design methodology of Dutch banknotes

Hans A.M. de Heij*
De Nederlandsche Bank NV, Amsterdam, The Netherlands

ABSTRACT

Since the introduction of a *design methodology* for Dutch banknotes, the quality of Dutch paper currency has improved in more than one way. The methodology in question provides for

- a *design policy*, which helps fix clear objectives,
- *design management*, to ensure a smooth co-operation between the graphic designer, printer, papermaker and central bank,
- a *Programme of Requirements* (POR), a banknote development guideline for all parties involved.

This systematic approach enables an objective selection of design proposals, including security features.
Furthermore, the project manager obtains regular feedback from the public by conducting market surveys. Each new design of a Netherlands Guilder (NLG) banknote issued by the Nederlandsche Bank over the past 50 years has been an improvement on its predecessor in terms of value recognition, security and durability.

Keywords: banknotes, design policy, design management, value recognition, security features, durability.

1. INTRODUCTION

The advent of euro banknotes in 2002 heralds an end to the circulation of the cherished Netherlands Guilder (NLG) banknotes. Dutch banknotes are unlike any other paper currency, because of their striking designs and unique *communicative aspects*. If you were to exhibit specimens of all of the world's banknote, the Dutch guilder notes would be among the easiest to spot.

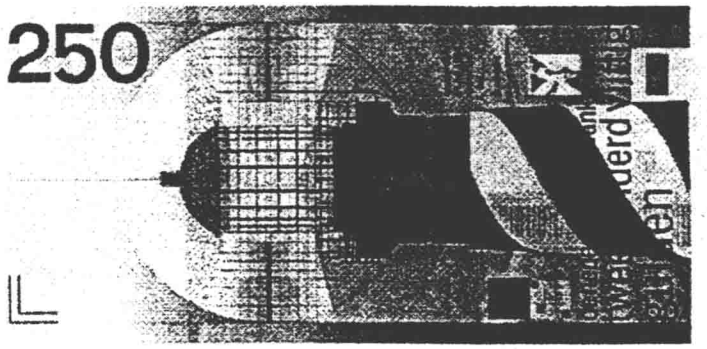

Figure 1
The NLG 250 banknote, also referred to as *the lighthouse*, was designed by R.D.E. Oxenaar and issued in 1986. Much liked for its appearance by 97 % of the public in 1999, it is the most popular Dutch banknote design.

*) Correspondence: Email: h.a.m.de.heij@dnb.nl

In *Optical Security and Counterfeit Deterrence Techniques III*, Rudolf L. van Renesse, Willem F Vliegenthart, Editors, Proceedings of SPIE Vol. 3973 (2000) • 0277-786X/00/$15.0

Dutch banknotes owe their popularity to a number of factors. For one, their design precludes confusion over the value of the notes. Furthermore, the average counterfeit rate is as low as approximately 7.5 per million of banknotes in circulation.
Another success factor is the public's appreciation of Dutch banknotes for their aesthetic merits. More than 75 % of the Dutch public think - over the years - NLG notes are *beautiful*. For the NLG 250 banknote (Figure 1), the appreciation percentage even exceeds 90 %! Featuring at many design exhibitions, Dutch banknotes often meet with positive response from art connoisseurs.
Finally, a well-controlled circulation of the NLG notes, including continuous replacement of tattered banknotes and a relatively long life, are other contributors to the success of the Dutch banknotes.

From a managerial point of view, the design process used for the production of Dutch banknotes leaves little to be desired, offering the following advantages:
a) less than 2 years from the date when the proposal for a new banknote is approved to the first day of issue,
b) low development costs: around EUR 1 million (for external costs, i.e. for the designer, paper mill and printer).

What makes Dutch banknotes so different? What does de Nederlandsche Bank (the Bank) do differently from other central banks to be able to achieve this result? This paper – a design testament of the NLG banknotes – will answer these questions, focussing on the following 6 aspects:

1. Pre-conditions
2. Design policy
3. Design management
4. Value recognition
5. Security features
6. Durability

2. PRE - CONDITIONS

One of the pre-conditions for the success of the Dutch banknote design has been Dutch legislation guaranteeing the Nederlandsche Bank's independence (see Figure 2). While today all the National Central Banks (NCBs) of the European System of Central Banks (ESCB) are independent of their Ministries of Finance, this has not always been the case. However, apart from World War II (1940-45) and the first years after that, the central

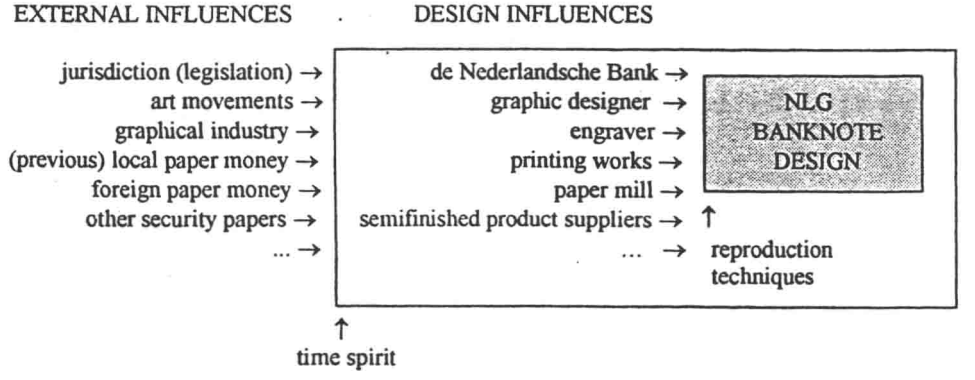

Figure 2
The design of a banknote is influenced by several external factors and by various design factors.
The decision to develop a new design is usually prompted by the arrival of new reproduction techniques, like photography around 1860 or colour copiers in the 1980's. The spirit of the time, too, may inspire new banknote designs.

bank of the Netherlands has enjoyed this independence since its establishment in 1814. The Central Bank Act of 1948 gave the Governing Board of the Bank again full authority over Dutch banknotes, underscoring this institution's independence. This authority implies that no parliamentary or ministerial approval is required for the creation of a new banknote and that the Bank is free to fix the denominations and designs of the notes.

But why would the Board of the Bank endorse proposals for new, innovative banknote designs, when it is supposed to play it safe? The answer lies in the many small steps made over the years towards a fully-fledged design methodology. The graduality of this process helped foster a *good feeling* among Board members about design. By the time a new banknote design was a regular Board Meeting agenda item (in the 1980's and 90's), this had become not much less than a *fun* item! Encouraged by the plaudits received for previous designs of the notes, the Board always felt challenged to take a design one step further every time a new banknote was to be produced.

One of the first design successes came in the 1930's, i.e. with the NLG 50/Minerva by graphic designer Jacob Jongert [1]. Further progress was made between 1948 and 1968 with work by designer Eppo Doeve (5 new models). In the following thirty years (1968 - 1997), the quality of Dutch banknote designs would rise to great heights, due to several actors, like the *time spirit* (see Figure 2). Besides meeting high standards, Dutch Public Design was very popular in that period (stamps, public telephones, public transport and road signs). Dutch Public Design was *in*. A similar time spirit prevailed in Switzerland, Denmark and the UK, for that matter.

Another important pre-condition is the *commercial* relationship that has existed between the Bank and the firm printing the Dutch banknotes, Joh. Enschedé, since 1814, the year when the Bank was founded. In this relationship the Bank is the party that commissions the printer to produce banknotes. In the course of time, however, the Bank grew accustomed to commissioning banknote designs as well. This is why, since 1890, the Bank has also acted as a direct principal of the paper mill (VHP), instead of leaving this task to the printer. And since 1880, the Bank has procured banknote paper from VHP, the only Dutch banknote paper supplier since 1945. In the early 1920's, the Bank hired its first engineer, entrusting him with the management of the technical aspects of banknote production.
After the arrival of banknote sorting machines in 1968, the Bank turned into an expert client of both the paper mill and the printer, recruiting printing specialists on its workforce. In 1981, the Bank added an industrial designer to its staff, who has since been in charge of the development of new banknotes.
Since 1860, graphic designing has been a trade conducted on a free lance basis. Since 1924, the Bank - and not the printer - has acted as a principal of graphic designers.

Another positive experience for the Board of the Bank was the public response it received through opinion polls. The Bank learned to listen to the people. Its first opinion poll was held in 1965 and served to gauge the public's view of a new low denomination, i.e. NLG 5. The same was done in 1981 for the Bank to find out what value a new high denomination between NLG 100 and NLG 1000 should represent in the eyes of the public. Also on the basis of the public preferences emerging from that survey, NLG 250 was chosen.
This survey was also the first occasion on which the Bank inquired after the appreciation of the latest NLG 100 note, popularly referred to as the Snipe, after the bird on the note's face. The introduction of an animal species marked a watershed in the long-established tradition of portraying mainly historical figures on NLG notes.

The *learning curve* is another actor in the Bank's banknote design policy. After a series design of 4 banknotes by R.D.E. Oxenaar (NLG 10, 25, 100 and 1000; in 1968-72), it became standard policy to issue new banknotes per denomination instead of by complete series, be it consistent with the style of previously issued banknotes. In 1987, the Bank organised a preliminary design contest for a new series of NLG notes. From then on, every new banknote was to feature more details and include new innovations, with the NLG 10/Kingfisher –'my best note' (designer Jaap Drupsteen) – marking the end of a long and valuable tradition (Figure 3).

Figure 3
The NLG 10/Kingfisher, designed by J.T.G. Drupsteen and issued in 1997.
Last note before the introduction of the euro. Greatly liked for its appearance by 93 % of the public (1999).

3. DESIGN POLICY

One of the basic requirements for any product design to be successful is having a design policy. The Dutch central bank has formulated this design policy as follows.

A banknote is a product for daily life. It changes hands many times a day, and is carried close to or even on bodies! Therefore, a note should first of all have an easily recognisable denomination and an attractive, contemporary look. In short, it should be designed for the public to like it. Therefore, it should neither be historical or educational, nor feature elements designed to please tourists, such as tulips, wooden shoes or windmills.

Considering NLG banknotes a means to express the contemporary Dutch culture, the Bank attracts well-known, top graphical designers from the *market*. In line with this policy, rather than searching existing literature for a poem suitable for the micro lettering section, the Bank commissions one from a contemporary poet. For the two latest NLG banknote designs, the Bank asked for brief texts befitting the notes' themes.

Many central banks' first concern is that their banknotes are designed to deter counterfeiters. The Nederlandsche Bank, however, gives priority to precluding confusion about its banknotes' denominations (see 3.1) over protection against counterfeiting (see 3.2), a maximum life (see 3.3) and an appearance reflecting Dutch culture (see 3.4), in the order given.

Subsequently, the Bank looks at banknotes through the eyes of marketing people. Who are its customers, for whom are the banknotes produced? The following user groups can be distinguished [2]:
- the general public, *the man in the street*,
- cashiers (e.g. supermarkets, gas stations),
- the central bank's sorting machines (detectors),
- banknote issue and acceptor machines (ATMs - Automated Teller Machines - and vending machines),
- copiers and scanners etcetera (*the counterfeiters*).

Furthermore, the Bank only issues banknotes whose value, security, text or any other feature it can account for.

The Bank's banknote policy is set out in detail in the following sub-paragraphs.

3.1. Value recognition at a glance

The public should be able to determine the value of a banknote at a single glance. The design should extend to the use of colours, the picture, numerals and other design elements. While not secure for obvious reasons, *Monopoly notes* fulfil this requirement, mainly because of their colours and easily distinguishable numerals! Opposite examples of such easy value recognition are US-Dollar banknotes, whose colours, portraits and numeral sizes until recently used to be all alike, irrespective of their denomination. They are the product of a design policy that proceeds from the assumption that an individual wishing to check the face value of the note is compelled to have such a close look, that a counterfeit note would stand little chance of escaping a user's notice. In 1996, the policy was changed in favour of value recognition: the portrait area of the USD 100 was enlarged, just as one of its numerals.

Paragraph 5 sets forth the value recognition theory.

3.2. Easy recognition of counterfeits

3.2.1. Limited number of security features

First of all, set a limit to the total number of security features. As the complexity resulting from an excess of

User group	Total	Security feature	Production technique	Main security principle
General public	4	1 watermark 2 see-through register 3 micro-text (0,3 mm) 4 tactility	1 paper 2 *simultaneous* offset 3 offset 4 intaglio	1 optical density 2 geometry 3 resolution 4 geometry (relief)
Cashier	3	5 fluorescent fibres 6 non-fluorescent paper 7 micro-text (0,2 mm) 8 size of banknote, cut at right angles	5 paper 6 paper 7 wet offset 8 cutting	5 colour 6 colour 7 resolution 8 geometry
Central bank	3	9 bar watermark (AQUS) 10 intaglio pattern (ISARD) 11 banknote number	9 paper 10 intaglio 11 letter press	9 optical density 10 geometry 11 geometry
Banknote issue and acceptor automates*	1	8 size of banknote - thickness of note - colour measurements - opacity measurement	8 cutting - paper + print - paper + print - paper + print	8 geometry - geometry - colour - opacity
Copiers and scanners	9	12 iridescent *planchettes* 13 foil seal, overprinted 14 iridescent ink 15 metallic ink 16 transparent inks 17 screen traps 18 colour outside *euroscale* 19 rain-bow printing 20 -	12 paper 13 hot stamp press and dry offset 14 silk screen 15 dry offset 16 intaglio 17 offset 18 dry offset 19 dry offset 20 -	12 optical density 13 optical density 14 optical density 15 optical density 16 optical density 17 geometry 18 colour 19 optical density 20 -
Total	20			

Table 1
Overview of security features in NLG 10/Kingfisher.
*) as far as known

security features decreases a banknote's security, the maximum number of security features on Dutch banknotes has been set at 20 (see Table 1). In short, if a new feature is added, another one has to go. Prevent *inflation* of security features!

3.2.2. User-specific security features

Target one user group per security feature. For optimum targeting, make sure a security feature is listed only once in the security features overview (see Table 1).

3.2.3. Clear visibility

Use features that are discernible in a genuine note, while appearing only partly or not at all in a counterfeit. Avoid texts like *VOID* or other features that *pop up* on a reproduced banknote. Every feature's colour, dimensions and resolution should be designed to ensure easy recognition.

3.2.4. Self-defending

Sooner spend more money on the security of the banknotes than on tracing counterfeits! In this respect, NLG banknotes are *self-defending*, i.e. it does not take an expert to prove they are genuine. As a consequence, their production costs are higher, though.
Features developed for detectors in colour copiers, scanning devices or graphic soft ware should preferable not be used in banknote design.

3.2.5. Use linked technologies

Security features should not be isolated - *island features* - but be linked with one of the other technologies by partly overlapping other features. For example, make sure that about 10 % of the watermark surface is overlapped by offset/intaglio, and that about 15 % of the surface of the foil is overprinted with dry offset.

3.2.6. Policy on public security features

a) The public should - at any time - be able to check a note for security without needing another note for reference, or tools.

Typically, security features for the general public can be checked *without* the aid of a tool or instrument. Neither is it necessary to compare one banknote with another. Features for the general public should be prominent for easy recognition and understanding, as well as permitting a description over the telephone.

b) Instead of making a habit of checking each note for genuineness, the public will only do so after being alerted, e.g., by a press release from the central bank. If there are more than e.g. 15 counterfeits per million notes in circulation, the central bank may consider releasing a statement to that effect.

c) A public feature should be resistant to all sorts of destructive treatments. For that reason, a foil cannot be a public security feature, since it may be affected by the use of detergents. Notes need not be fire-resistant, though.

d) The security features and their communicative functions should be applied consistently throughout a banknote series. In other words, the banknotes in one series should all have identical and identically arranged features to make it easy for the public to familiarise itself with denomination-specific features and feature configurations.
Given that surveys show that the public is able to recall about 1.7 security features (measured in 1999), it does not make much sense to have more than 4 public security features in one banknote.