PAPER INNOVATIONS IN NEW DUTCH BANKNOTE D2

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1 INTRODUCTION

The next new banknote that the Nederlandsche Bank will issue later this year contains three important paper improvements:
1 very light details in the watermark,
2 iridescent planchettes on the back of the note,
3 PVA sizing instead of gelatine-formaldehyde.

Below I will highlight these three innovations in short.

2 VERY LIGHT DETAILS IN WATERMARK

When we started with the second note of our new abstract design series (in code the D2) in late-1989, we asked our paper manufacturer VHP Security Papermill if they could offer us new features. At that time, one of the subjects the research Department of VHP was working on was the use of relatively small, but very light details in the watermark. This can be done by means of solder copper micro elements on the wire netting of the mould. VHP had made some examples among which an owl, a night bird with two big eyes. The pupil was dark and the iris was very light. It had already been decided that the watermark in the D2 would be a bird. From the example of VHP it was clear that the micro elements could be used very well for the eyes of an owl. With this in mind, Mr. Drupsteen designed the watermark Little Owl, a bird that can be found in Dutch nature (Figure 1).
FIGURE 1

Sketch of watermark Little Owl (left) and micro elements for the eyes (right), both designed by Jaap Drupsteen. The micro elements can be made in different shapes and have a small hole, which can also have different shapes. The size of the micro element is about 3 mm and the hole is about 1 mm.

During the production of the watermark Little Owl there were three items that VHF monitored carefully:
1. are the two micro elements well placed; is the Little Owl not cross-eyed?
2. are all micro elements still on the mould?
3. are there any small holes in the light parts?

Fortunately, only minor problems occurred with regard to the introduction of these micro elements.

In our own scanner/offset reproductions the light details are not better printed, they have the same density as other light parts of the watermark. In colour copies the light details are sometimes, with a black paper under the note reproduced, while the rest of the watermark is not. Of course in both, offset and colour copy, never in through sight, the only way to check for a watermark.
3 IRIDESCENT PLANCHETTES

The second improvement that VHP suggested for the D2 was the use of iridescent planchettes. As you recall, Mexico was the first to introduce iridescent planchettes in the 50,000 Pesos note in 1989.

3.1 DESIGN

The assignment for the D2 note was to protect it especially against colour copy machines. One of the main physical principles to do this is to introduce highly reflective elements. That was and still is what we are looking for.

With the D2 we introduced hotstamp foil and lustre inks like iridescent silk screen inks and metallic offset inks. The iridescent planchettes also fitted in this strategy. Not in the first place because of the iridescent effect but because of their lustre.

Because the back of the D2 did not have many shiny elements we thought of using the planchettes here.

Figure 2
Sheet with planchette sections
Planchettes are distributed on the mould side of the paper and their orientation is cylinder direction. Because our paper is long-grain, the paper fibres are in the longitudinal direction of the notes; the planchettes are also in this direction. Another thing was that we wanted to limit the width of the planchette section. This was done by cutting the planchette area in two as is drawn in Figure 2.

3.2 PRODUCTION ASPECTS

The largest technical problem is of course the adhesion of the planchettes to the paper. This is not only due to the poor adhesion of cotton and plastic, but also because of two contradictory requirements:
1. planchettes should be on the paper surface,
2. planchettes should stick to the paper during printing and circulation.

Another major technical problem for the paper mill is the distribution of the planchettes. First of all, planchettes may not stick on top of each other. Further, planchettes should be spread at random but within limits. There should always be a minimum number of planchettes in a section and the planchettes should not be located too far from each other. Furthermore there should not be too many wanderers, too many planchettes outside the sections.

VHP has made a considerable investment in the distribution technique of the planchettes. After intensive testing they succeeded well.

After the paper production the sheets with the planchettes must be printed. Our printing works, Joh. Enschedé, was at first not very pleased with the introduction of the planchettes. Their major concern was of course that the plates of the printing presses would become filthy. As you will imagine this can have disastrous results. Fortunately, after two printing tests the conclusion of Joh. Enschedé was that the planchettes sticked very well to the paper. There is no loss of printing efficiency due to the planchettes.
The trials also showed that the planchettes could be easily overprinted with both dry and wet offset. A lost planchette under the foil is considered a minor problem, just as a wanderer in the watermark area.

We have also performed some tests with the D2 banknotes on our Toshiba sorting machines. Here too the planchettes did not disturb a proper production; we very rarely find a single planchette. There was one minor incident: once, waving through a package of new D2 notes, a planchette jumped into the eye of one of our employees!

When NCR was testing the new D2 in their Automated Teller Machines (ATM), a few planchettes were found, too. If these planchettes stick to the sensors or the vacuum system the proper working of the ATM can be disturbed. During the tests this was not the case.

Finally, we have done some imitation circulation tests on laboratory scale. These tests showed that planchettes can be removed from the banknote by using your finger nails. Of course we are very curious how the planchettes will behave in circulation. We know that we take some risks here but we think it will help to limit the D2 colour copy reproductions.

3.3 PLANCHETTE SPECIFICATIONS

VHP chose for planchettes made by Mearl.

The specifications of the planchettes used are:

**Material**

The material of which the planchettes are made is:
- top and bottom surface layer: impact modified acryllic,
- inner optical structure: polyester and acryllic.
Free of toxic materials
The planchettes do not contain toxic materials.

Shape
The planchettes have a hexagone design. The angle length is 1 mm and the largest width is 1.7 mm (Figure 3).

FIGURE 3
Planchettes in D2-note (left)
Shape and dimensions of planchette (right)

Thickness
The thickness of the planchette is 31 µm.

Colour
The colour of the iridescent planchettes is red/green.

Iridescent effect
The iridescent effect of the planchettes is assessed by placing one planchette on a black background. The colour perception is then green. On a white background the colour perception should be red.
Lustre

Unfortunately the planchettes are too small for lustre measurements.

Mould side

The iridescent planchettes are located on the mould side of the paper (the back of the note).

**Planchettes in sheet**

For each planchette section in a sheet there should be:
- a maximum of 155 planchettes in a sheet length,
- a minimum of 65 planchettes in a sheet length.

In production terms there are approximately 2.5 grammes of planchettes on 1 kg of paper.
The width of a planchette section in a sheet is 30 mm.

**Planchettes in note**

After the sheets are cut into notes this means that there should be at least 13 planchettes in a note. We asked for at least 5 planchettes in the upper strip and at least 5 planchettes in the lower strip.
The width of both the top and bottom planchette strip in a note is 15 mm.

**Wanderers**

The number of planchettes in a sheet that are outside the planchette strips of the transparent control plate is at most 30/sheet.

**Costs**

Due to some loss of production efficiency the paper price of the D2 increased to reasonable proportions, for both the very light elements and the iridescent planchettes.
4 PVA SIZING

The last improvement in the D2-paper is the tub sizing. We (finally) changed for environmental reasons from gelatine to Poly Vinyl Alcohol (PVA). Not because of the gelatine itself, but because of the formaldehyde that has to be used as a 'cross linker' during the paper production. Using formaldehyde in the paper machine creates formaldehyde gas. This gas is irritating for the eyes and bronchial tubes. The legal norms for formaldehyde gas will be tightened more and more in the future.

Formaldehyde is used to harden the gelatine glue so that it becomes waterproof and bactericide-resistant. The PVA has the same functions: make the paper waterproof and resistant to bacteria.

Changing the top layer of the paper of course has implications for the printer; not only for the printability, but also for the glue layer of the hotstamped foil. In the D2 the foil sticks directly on the paper surface, the PVA tub sizing.

In a very early stage of the design process, in 1991, Joh. Enschedé did some experiments with PVA tub sized paper. These first test were positive. There were also no major effects found on our paper specifications like roughness, wet tensile strength or opacity. The final conclusion of the printer in 1992 was that it is good printing with PVA!

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