INTERNATIONAL REVIEW ON CASH MANAGEMENT

BILLETARIA

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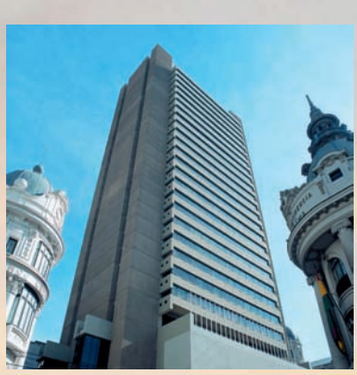

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Editorial

■ **J. Darío Negueruela** *Banco de España*

This issue of BILLETARIA is dedicated almost exclusively to examining and giving an overview of the modern substrates the paper industry is offering banknote manufacturers and printers today. Issue 5 of BILLETARIA in April 2009 focused on the use of polymer, a significant new development in the banknote industry which radically changed the landscape by introducing a powerful alternative to paper as the substrate on which to print banknotes. Polymer initially seemed an expensive option, but it offered some genuinely attractive features and the future promised to be interesting. The proof that this alternative's benefits were more than just a sales pitch is that today, in mid-2011, there are over nineteen countries issuing banknotes printed on polymer, with the number of polymer banknotes in circulation possibly exceeding five billion units.

We have said more than once that, in our opinion, one of the aspects for which we should be grateful to the firms that introduced polymer is not just that they have offered an alternative, but that they have stirred up the otherwise calm waters of the banknote industry. The fact is that paper manufacturers have responded to the challenge of polymer and the new substrates now on the market show they have clearly perceived the need to offer alternatives that meet today's demands. More active communication between customers, management in a globally connected world, advances in technology and the pressure of cost control to which issuers are today subject, all call for new and better banknote substrates. Central Banks' typically conservative attitude has given way to a constant search for better features, more strength and lower prices, apart from the obvious concerns with hygiene, health and the environment.

Autumn colours? / JDN

The first part of this issue, following the interview with Leopold Surga, an old friend known to everyone in the banknote world, and for whose contribution we express our sincerest thanks, is devoted to presenting the new products some leading paper manufacturers are currently offering. Obviously, we cannot include them all but we believe the sample is sufficiently representative of the scale of the industry's reaction and the ever expanding range of options available to anyone looking for a new type of paper as an alternative to polymer. The second part, after the customary section presenting Latin American banknotes and central bank cash departments, offers a series of reports and analyses by experts at various central banks on products that they have previously presented or on common aspects of the general issue of banknote substrates. These presentations, therefore, aim to complement or counterpoint the information offered in the first section of the journal.

Given the issue's specific focus, our usual section on security features has been modified slightly in this instance to focus on those that are specific to the paper substrate.

Finally, the journal's editorial team has made a brief but interesting review of a number of publications on cash and a summary is given in an box which we hope may be of use to our readers. As always, we have not aimed to be exhaustive or to go into analysis of matters beyond our scope. Our aim is simply to highlight the fact that there is a growing number of journals on the topic which is something we interpret as a positive sign.

On 11 March 2011, while the first proofs of this issue of BILLETARIA were at the printers, news arrived of the earthquake that devastated a large area of Japan leaving countless victims and huge material damage in its wake. Our thoughts and feelings of support and solidarity go out to all those affected by this terrible tragedy, to whom we send our sincerest condolences.

CONTRIBUTORS

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Interview with Leopold Surga

■ **Fernando León** *Banco de España*

Leopold Surga was born in 1947. He graduated from the Law faculty of the Charles University in Prague in June 1970 and in August of that same year started working at the National Bank of Czechoslovakia as an expert on currency counterfeiting in the Accounts and Cash Department. In 1992 he was appointed as Executive Director of the Cash Department, where his first major task was running the introduction of the Czech Republic's new currency and exchanging the existing Czechoslovak banknotes and coins in circulation. In 1996 he was appointed as the Czech Republic's Central Bank's representative on the Statistics and Banknote Handling Committee of the Banknote Printers Conference and in 1999 he joined the Central Bank Counterfeit Deterrence Group (CBCDG). In 2001, following a reorganisation at the bank, he was appointed as Executive Deputy Director of the Cash and Payment Systems Department. Since 2003 he has been Czech National Bank's representative on the Banknotes Committee of the European System of Central Banks, and on the Euro Counterfeiting Experts Group, the Euro Coin Sub-Committee (ECSC) and the Mint Directors' Working Group (MDWG). Between 1992 and 2010 he was Chairman of the panel undertaking a study on new Czech banknotes and coins. He retired in February 2010.

L. Surga

F. León

When he retired, Leopold Surga had held responsibilities in the banknotes and cash management area for forty years. I first met Leopold Surga in 1996 in the Statistic and Banknote Handling Committee of the Banknote Printers Conference, when he took part as the representative of the Czech National Bank, and I was immediately struck by his warm personality, his unhurried and cordial tone, strong sense of responsibility and his experience when talking about cash-related issues. During our interview, Leopold deals with almost all aspects of the topic of banknotes and cash management.

Q. You worked for *Óeská národní banka*, the *Central Bank of the Czech Republic*, for a long period of time. How much of this time did you spend in the Cash Department?

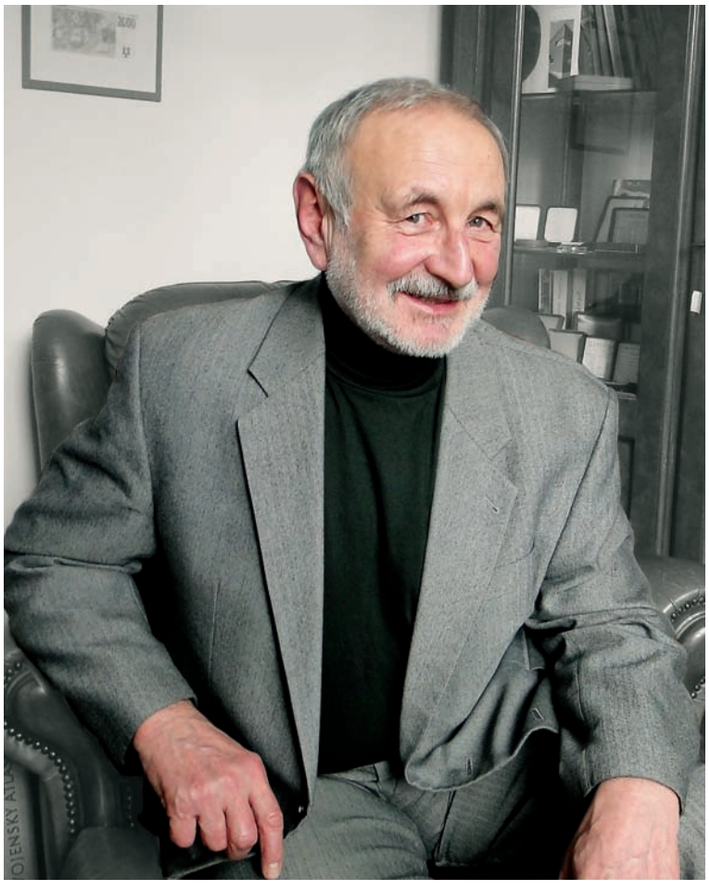
A. I started working at what was then the *Central Bank of Czechoslovakia* in July 1970, as soon as I had obtained my degree from the Law faculty of the Charles University in Prague. The Czech National Bank came into existence on 1 January 1993, after the partition of the former Czechoslovakia in two independent states, the Czech Republic and Slovakia, which led to the partition of the common Central Bank into two central banks: the *Czech National Bank* and the *National Bank of Slovakia*.

I have been involved in cash matters throughout my career. My first job was in the Accounts and Cash Department, where I was responsible for a variety of tasks. First of all, I worked at a branch of the Central Bank in Prague. I found learning about cash operations hands-on to be useful and the experience I acquired was very valuable to me later on when I was in charge of drawing up internal rules and standards, central bank regulations and draft bills submitted to Parliament. For example, part four of the Law establishing the Central Bank's Functions and Standards of Operation is devoted to regulating banknote and coin circulation. It was drafted by our department and summarises all my experience and that of my colleagues. I also worked as an expert in the counterfeiting area, which was useful experience when I had to contribute to preparing legislation on the subject, which was included in the former Czech penal code.

Q. Let's talk about banknote manufacturing and procurement. What is the Czech National Bank's model of banknote procurement? What is your personal point of view on the banknote procurement system?

A. Article 2 of the Law defines the Czech National Bank's functions and standards of operation and establishes that, in accordance with its principal objectives, among other tasks, the Central Bank will issue banknotes and coins, manage the circulation of the currency, and promote efficient and smooth operations. The Czech mint and state printing works in Prague are independent bodies that do not belong to the Bank. Being subject to national legislation, the Bank is obliged to act according to the laws governing competitive open bidding and obtains coins by means of

Picture of Praga



a tender process. Procurement of banknotes is not subject to tender due to an exemption granted in view of the need to protect banknote security features.

Production by both the mint and the printing works is of very high quality and, in the case of coins, the Czech mint offers the lowest prices. Our discussions with counterparts at various other central banks have made it clear to us that the price we pay for our banknotes is also very competitive and we have no grounds to change supplier. The Cash Department also keeps in contact directly with the suppliers of the mint and banknote printing works and has signed three-way agreements specifying in detail the quality of the materials used (blanks, paper, inks, etc). I favour quality and my personal opinion is that quality and prices must be given the same importance in the decision-making process.

The Czech National Bank verifies the quality of deliveries from manufacturers in minute detail. The Cash Department has kept strategic reserves at levels which make it possible to reject manufacturing defects without risking emergencies or crises. We soon learned that a penalty clause in a contract, even when it imposes significant economic penalties for defective batches, is useless if the vaults are empty and there are only a few banknotes and coins that can be put into circulation.

Q. Has the Czech Republic designed a strategic plan of action for its responsibility in the cash cycle? Has it defined basic principles or limits regarding the management of banknotes and coins?

A. Despite the problems of the public finances and the government's budget deficit, the Bank's long-term goal remains unchanged: membership of the euro. The basic principles of cash circulation are established by European legislation. For example, Council Regulations (CE) numbers 1338/2001 and 44/2008 and ECB documents such as that establishing the principles and objectives of the Eurosystem in the cash cycle and the Decision on the authenticity and fitness checking and recirculation of euro banknotes. These are regulations the Bank will be obliged to comply with and its short and medium term plans include the implementation of individual measures to achieve this goal. As regards legislation, for example, a completely new regulation concerning circulation of banknotes and coins has been passed by Parliament following consultation with the ECB.

There is also an important plan for the management and circulation of cash, with a view to the Central Bank being strong enough to directly influence the market. The aim is to penetrate the market and increase its influence on the flows of banknotes and coins in circulation. From an operational standpoint, the Bank has successfully run a pilot banknote sorting test in a multi-denominational system at one of its branches which is considered to be a high-quality service offered to credit institutions and customers. We think this could be a powerful instrument from various points of view: strengthening the position of the Bank, improving the quality of circulating banknotes, prudential behaviour, etc.

Q. Should a central bank provide cash services to the public or should its activity concentrate on professional cash handlers?

A. The Czech National Bank offers only a limited number of services to the public. Its branches exchange mutilated banknotes and coins, give change for Czech banknotes and coins and exchange currency which has ceased to be legal tender. These services are provided free of charge. As the issuer of the banknotes and coins in circulation, the Bank must provide these services or guarantee that they are provided by third parties. Generally, the customers of the cash area are credit institutions and bodies funded out of the State budget. Going forward there are plans to offer cash services to supermarket chains. Unlike some other central banks, the Czech National Bank does not exchange foreign currency for the public or provide any financial products to private individuals.

Q. Do you think that outsourcing is the key to efficiency in cash management?

A. Let me ask you a couple of questions back: what does efficiency mean in relation to cash management? Does anyone know how much putting a thousand banknotes into circulation costs, to use it as the reference when deciding whether a central bank is either modern and efficient or, on the other hand, obsolete and inefficient? Every central bank needs to be aware of its strengths and weaknesses. I am very sceptical about outsourcing any of a central bank's essential tasks which have been assigned to it by law. A central bank has to control all the activities relating to currency circulation. The central bank must retain control over the quality of the banknotes put into circulation and supervise and check up on any institutions which provide these services on its behalf. The central bank must also be prudent and not rely on the capabilities of third parties.

This situation differs from country to country according to size, legislation, the number of credit institutions, and the number of cash-in-transit companies, etc. not to mention traditions. First of all, it is necessary to take a look at the quality of the banknotes and coins in circulation, the fluidity of circulation, the volume of unprocessed banknotes and coins, lodgement and payment figures, etc. It is possible to compare the number of banknotes put into and withdrawn from circulation, the number of employees involved in cash operations, operating costs, overheads, etc., but these figures include many different payments, compensations and reimbursement to the organisations to which these tasks have been entrusted.

Q. Which are the pros and cons of issuing high denomination banknotes? What advice would you give to counterparts at other central banks on this issue?

A. When we prepared our new series of banknotes in 1991 and 1992 we had to argue for the inclusion of a CZK 5,000 banknote (approximately €200). People said it was too high a denomination, too expensive and would

A day at the seaside / JDN

facilitate black-market transactions, etc. However, on various occasions, we have had grounds to feel pleased with having issued this denomination. In the new economic conditions, under capitalism, companies are worried about their partners' insolvency or bankruptcy and, therefore, prefer cash payments to those using alternative payment instruments. Ten years ago, when one of our most important banks failed, the public withdrew around CZK 20 billion in cash in the space of just a few days. The same situation occurred in October and November 2008, when the banking crisis reached Europe, but involving twice the amount. The CZK 5,000 note represents approximately 32% of the value of circulating banknotes and 7% in terms of volume. This banknote's value is equivalent to almost 20% of the average salary, which seems reasonable

Q. Do you think that the relationship between these, the central bank, credit institutions and cash-in-transit firms, is an essential factor in currency management?

A. These relationships must be solid and constant, as this will help successfully resolve problems quickly. It is also important that the central bank, given that it is responsible for currency circulation, keeps tight control over these companies as they are agents that play an important role in the market and are capable of altering currency flows, as well as the quality of the banknotes and coins in circulation.

Q. What do you feel is the main threat to coins?

A. No credit institution likes handling coins. They have to be counted, checked for authenticity and exchanged if they are damaged or unfit for use in vending machines. Medium-to-low denomination coins are generally unpopular because they have very little value and nobody wants to receive them in their change. They are only popular with the people who run the mint, as producing them is a never-ending story. The public hoards them at home rather than deposit them in the bank. Credit institutions, therefore, demand ever more coins for their customers. The result is an increase in the production of this type of coin which, moreover, cost more to mint than they are worth.

Q. What can you say about the fight against counterfeiting?

A. Well trained staff in credit institutions branches and *bureaux de change*, good legislation, effective cooperation between central banks, police and competent national authorities at state and international level, concentrated information at national analysis centres, etc.

Thank you, Leopold we have to end our interesting discussion there. Thank you for kindly agreeing to talk to BILLETARIA and sharing some of your extensive knowledge of the currency world with our readers.

Hybrid substrates: the future is now

■ **Clemens Berger** *Louisenthal*

This article reports on hybrid substrates, one of the most significant new products to have emerged recently in the substrates field. *Hybrid™*, *Louisenthal's* contribution to this area, is a product combining the intrinsic advantages of cotton and polymer in a single product. *Hybrid™* is a proven technology, with banknotes in circulation in three countries in Africa for the last two years. In a competitive market, hybrid substrates are now a fully commercially available product and are setting the trend as a real market alternative.

What are central banks looking for?

Central banks are interested in obtaining a banknote substrate that meets a range of requirements:

- Improving the soiling resistance offered by cotton paper banknotes.
- Improving the ink retention of polymer banknotes.
- Retaining the option of embedding security features in the substrate.
- Continuing to offer the confidence given by the touch and feel of cotton-paper banknotes.
- Preventing a monopoly of substrate supply or restrictions deriving from patent rights.

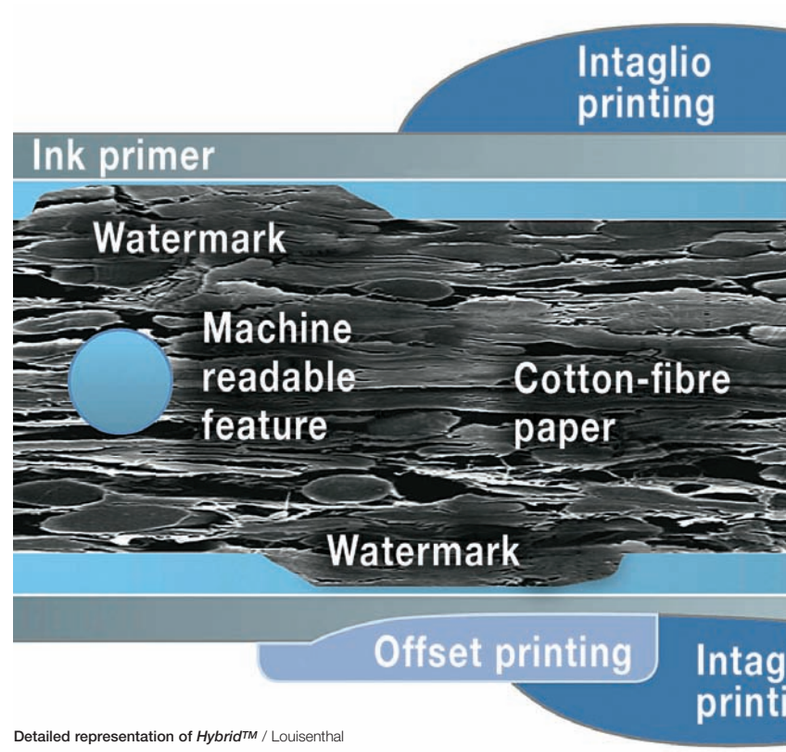
Specifications of *Hybrid™*

Hybrid™ is a combination of a cotton fibre core with a protective film layer on either side. The core can be adapted to each denomination to include all the required security features, such as watermarks, security threads, transparent windows and machine readable features. The 72 g/m² cotton fibre core remains of sufficient thickness to incorporate both visible and concealed security features in the substrate, thus ensuring the banknote is protected against counterfeiting.

The cotton-fibre core enables deep intaglio embossing and, thanks to the polyester film enclosing and protecting it, a long-lasting banknote is obtained which remains clean and stiff even under extreme conditions of circulation. The soft polyester surface enables fine line sharpness to be obtained from printed elements. Moreover, the specific adhesive ink layer increases banknote quality during its lifetime which, in combination with intaglio printing, produces the familiar touch and feel of paper.

The *Hybrid™* production process

- A cylindrical mould process is used to produce the cotton-fibre core.
- The watermark, security threads and machine-readable security elements are embedded in the substrate during sheet production. The core resembles that of cotton-paper banknotes.
- The *Filgram™* window or transparent window incorporated in the cotton core is cut by laser.
- The core is laminated with a protective polyester film on both sides using suitable adhesive substances so that the security features are sealed inside. The substrate resembles plastic.
- The layer of adhesive link which is applied to each side of the polyester film facilitates the use of printing inks. The substrate resembles paper again.



Detailed representation of *Hybrid™* / Louisenthal

- Security inks and holographic strips are applied before finishing and shipment to the banknote printing works. The substrate has an identical touch and feel to that of a banknote produced from cotton paper after intaglio printing.

Hybrid™ embedded security features

The substrate is designed to incorporate three categories of security feature embedded in its core:

- Level 1 security features, which are easily verified by the public, such as watermarks, security threads, or *Filgram* windows.
- Transparent or self-verifiable windows or windows incorporating micro-optical elements.
- Level 2 and 3 security features, verifiable by sorting machines at both financial institutions and central banks.
- The fact that *Hybrid™'s* materials and production process are not commercially available safeguard its security.

Level of development of banknote security solutions

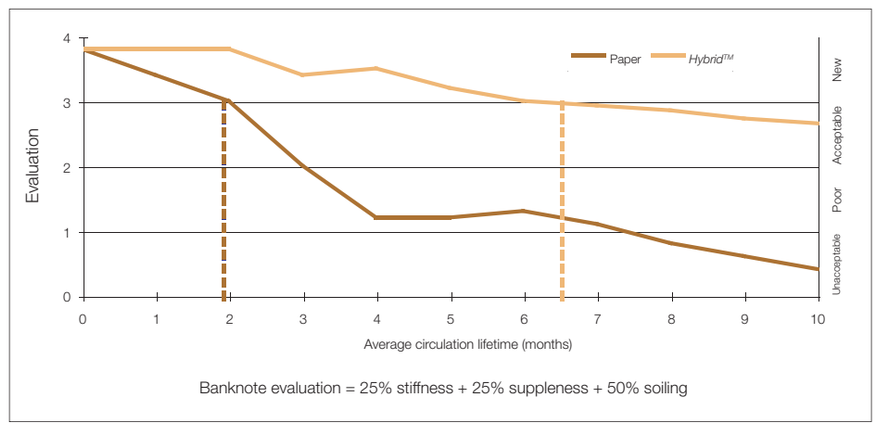
In order to tackle high-quality banknote counterfeits, it is essential to include sophisticated level 1, 2 and 3 security features. A banknote manufactured with *Hybrid™* includes:

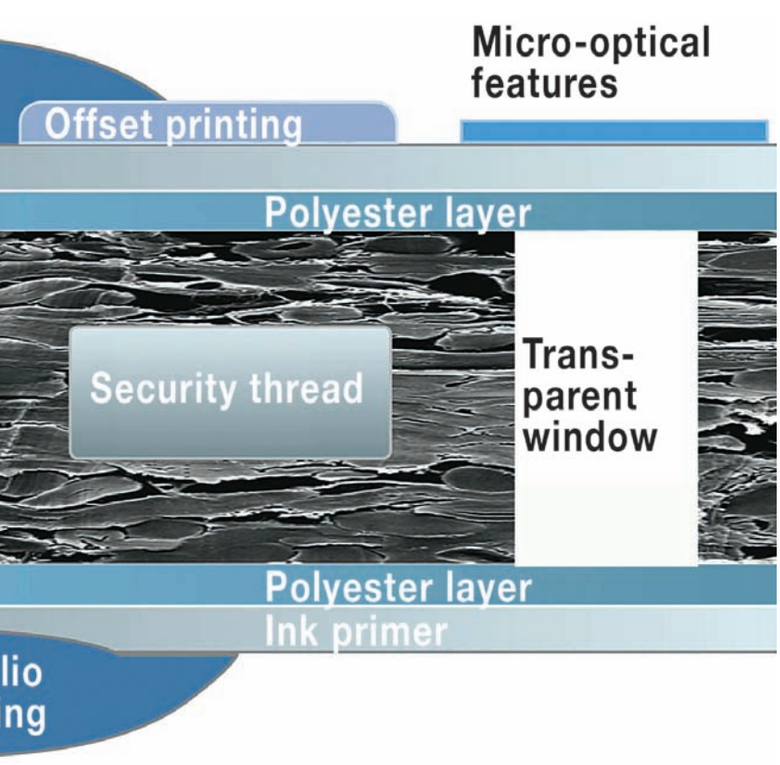
- *Pixel™* technology watermark, the security feature most frequently checked by the public.
- A security thread with the next generation of *Multi-code™*, which includes specific magnetic coding for each denomination and can be verified by sorting machines at financial institutions.
- *M-feature*, a specific level 3 element for central bank verification, providing the level of security currently needed at any stage in the cash cycle in order to maintain public trust in cash.

Quality throughout the banknote's lifetime

The *Giesecke & Devrient* banknote analysis method has been used to evaluate cotton paper banknotes and those manufactured with *Hybrid™* taken from circulation in an African country at 10 month intervals. *Hybrid™* banknotes still look new three times longer than their cotton-paper equivalents and remained in the acceptable range of the scale throughout the whole evaluation period. Banknotes manufactured with cotton paper fall into the low quality category practically three months after going into circulation and are of unacceptable quality after seven and a half months (see Graph 1). *Hybrid™* therefore showed itself to be at least three times as durable as banknotes made from cotton paper.

Graph 1. Durability of banknotes manufactured from *Hybrid™* compared with cotton-paper banknotes





Public acceptance

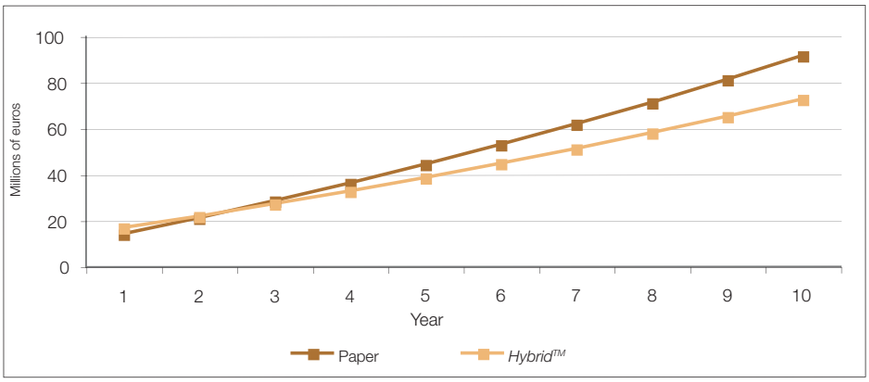
The familiar touch and feel of *Hybrid™* is considered by the public as a deterrent feature preventing the acceptance of counterfeits and central banks did not require any special training to be organised when the new substrate was put into circulation. *Hybrid™* can be used for a denomination that is part of a series, as its similarity to cotton-fibre papers means minimal adaptation of design, printing and sorting is required.

Banknote printing and automated processing

The similarities between *Hybrid™* substrate banknotes and cotton-paper banknotes make the adaptations necessary for the design and printing of *Hybrid™* banknotes minimal. Only minor adjustments to the ink are required in the drying process when intaglio and offset inks are used in combination to print on polymer.

This substrate has shown itself to have similar characteristics to cotton paper when handled by automated equipment. Tests performed on BPS M7 sorting systems have demonstrated that no difficulties arise in high-speed automated sorting. The loss of stiffness typical of lower denomination, which can be an obstacle automated processing, is resolved by the extra stiffness given by *Hybrid™*. It is also suitable for the online shredding

Graph 2. Total cost of banknotes



and briquetting commonly used to deal with cotton paper banknotes at the end of their lifetime.

The economics of hybrid for a medium-sized country

When *Hybrid™* is used, the volume of banknotes that need to be manufactured annually is significantly lower than is the case with cotton paper, given that Hybrid™ banknotes retain their durability and quality in circulation much longer. Whatever the substrate, production requirements in the first year of introduction of a new banknote are significant. The annual percentage replacement rate of unfit banknotes will increase over time. Printing requirements for banknotes manufactured with *Hybrid™* will be lower than in the case of banknotes with cotton paper because their substitution rate is lower due to the increased durability of the substrate and their longer average lifetime in circulation.

The greater durability of *Hybrid™* means that, over a ten-year period, the total cost of banknotes using this substrate is significantly lower than in the case of cotton paper banknotes. The total cumulative cost savings from adopting the new substrate are given by the difference in the 10th year between the cost of banknotes manufactured with *Hybrid™* and those manufactured with paper. The comparison shows the adoption of *Hybrid™* is to be cost-effective from year two (see Graph 2).

Competitive offering

Hybrid™ is patent-free. Therefore, other suppliers can develop similar products and contribute to establishing a standard hybrid-substrate industry. The leading suppliers in the substrate sector are now introducing their own hybrid substrates on the market. This will enable central banks to benefit both from hybrid technology and a competitive range to obtain better prices than would be obtained in an industry with a single supplier. *Louisenthal's* production capacity of the completely finalised *Hybrid™* product is 3,000 tonnes a year.

Concluding remarks

Central banks have the option of choosing a new cotton-based substrate which combines the advantage of cotton paper with those of polymer. Banknotes manufactured with *Hybrid™* have shown themselves to perform well under real-life circulation conditions in many countries and can be supplied competitively by leading suppliers in the substrates industry. Banknotes manufactured with hybrid support the incorporation of security elements using the latest technology on three levels of authentication, guaranteeing banknote protection against counterfeiting. Moreover, these banknotes have similar durability to those manufactured from polymer. Banknotes produced with *Hybrid™* maintain the tactile qualities of those manufactured exclusively with cotton-based paper, which inspires public confidence. Hybrids have ceased to be a product of the future and now form part of the line up of substrates in their own right.

(continued from page 9)

Some observations on technological developments in durable substrates

Original banknote and after a circulation trial (left). Original banknote with *Endurance* paper and the same banknote after a circulation trial (right) / *Crane Currency*

AST™-treated paper. The result is a durable banknote which benefits from a core of durable fibres, a polymer resin infusion during the paper manufacturing process, transformation during the intaglio printing process and, finally, post-varnishing. This concept is valid for all denominations in a banknote series, although it is usually most appropriate for low denominations, which rarely return to the central bank.

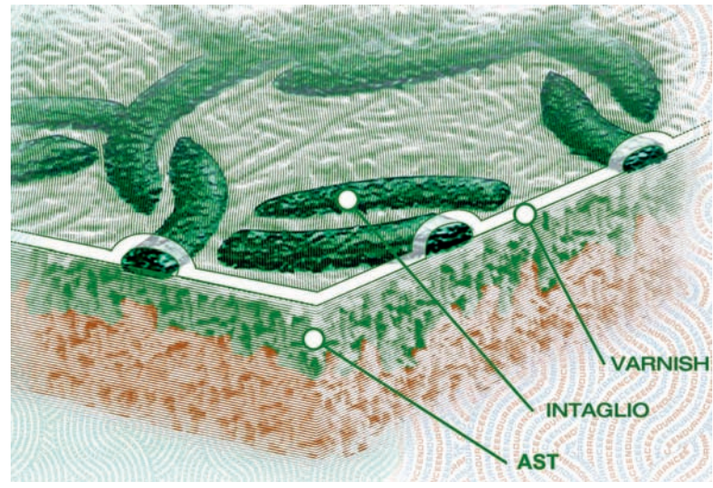
The cost is relatively moderate in comparison with the extension of banknote lifetime by around 30%. A licence is only required for use of *AST™*, which ensures paper manufacturers are able to freely implement the *Endurance* concept.

Perhaps the biggest advantage of *Crane Currency's* approach is the utilisation of the industry's installed equipment base. No new machines or processes are required. What is required however, are systems based on processes looking at the banknote from the fibres, through the paper up to the finished banknote. *Crane Currency* has developed its durable banknote solution for its customers and the market in general with two underlying principles: improving the substrate formulation and maintaining existing manufacturing processes.

Some observations on technological developments in durable substrates

■ **Timothy Crane** *Crane Currency*

Ten years ago there was just paper and polymer. Over the last decade paper manufacturers have developed a wide range of durable substrates, however. Today, the most commercially successful durable substrates are relatively conventional papers coated with a soiling resistant layer. More or less in parallel, post-printing banknote varnishing has emerged as a solution enabling the durability of all types of substrates to be enhanced.



Structure of *Endurance* / Crane Currency

The concept of durable paper

Durable paper has recently managed to make the market's perception that only paper will do a thing of the past. Today, the range available includes multilayer plastic-paper-plastic substrates, extruded paper-polymer-paper laminate substrates, substrates with reinforced synthetic fibre structures, and varnished papers. The market is fragmented, customers are confused and several of these substrates have virtually insignificant levels of market penetration. This mix of products includes more durable substrates, but they do not sell, basically because a durable substrate is difficult to define in an objective and technical way that is able to stimulate competition and exclude low performance variants.

Paper and polymer

Crane has a long tradition of manufacturing durable paper. As the manufacturer of paper for US banknotes, together with the more recent development of the *AST™* paper family (anti-soiling treatment), the firm produces more durable paper than any other manufacturer. Moreover, recently the foundations have been laid for a new concept of durable paper for banknotes called *Endurance™* which consists of the application of anti-soiling treatment to the paper followed by varnishing of the printed banknotes (*AST™* plus post-printing varnishing). *Crane* is not averse to using exotic solutions and has tried a number of them. However, we believe that a durable substrate core made of natural fibres mixed with a polymer saturation is the best way of combining paper and polymer. This approach allows sufficiently well-tested security features to be included and it represents a pragmatic solution to the problem of producing a longer-lasting secure banknote which performs well in circulation. The output of *AST™* papers accounts for almost half the paper manufactured by *Crane* at its Tumba mill (Sweden) over the last four years.

Effect of intaglio printing

AST™ functions differentially from paper to which traditional varnishes are applied as it is able to exploit the transformative advantages of the intaglio printing process. The pressure applied during intaglio printing forces the ink into the pore structure of the paper and simultaneously seals the paper surface, reducing its porosity and improving its soiling resistance, even in the case of most ordinary paper types. With the *AST™* polymer embedded inside the fibre matrix during the paper manufacturing process, the effect of intaglio printing is multiplied. The fibre matrix becomes less porous as a result of its increased density and the flow of polymer within it. This is totally different from what happens with varnished paper, where the resin and other components of the varnish are deposited on paper surface.

The *Endurance* concept

Endurance leverages the presence of banknote varnishing equipment at printing works around the world. Substrates based on polymer materials also need to be varnished after the printing process. The absence of this varnish layer would mean that banknotes lose their ink and coatings. When a banknote made from durable paper substrate is compared with one produced using polymer, what should paper manufacturers devise other than varnish as part of the solution?

A specific chemical affinity between the *AST™* polymer and various varnishes was developed for *Endurance*. Post-varnishing banknotes after printing means that the ink and security elements are encapsulated within a protective shield formed by the outer varnish layer and the underlying

The *Endurance* banknote is engineered from the four interconnected banknote security and durability elements:

- Mechanical strength of the durable fibre core.
- Anti-soil treatment (*AST™*), which saturates and coats the fibre surface
- Intaglio printing, sealing the surface and driving the ink into the fibre layer
- Protective varnishing, post-printing, that bonds to both the ink and the saturated fibre surface

(continued on page 8)

Durasafe®: the contribution from *Landqart*

■ **Andrew Bonnell** *Landqart AG*

The introduction of polymer stimulated major changes in the conservative banknote industry. Although many paper manufacturers and banknote printers saw disadvantages in this new material, its use has registered unbroken growth. Central banks showed particular interest in the step forward polymer represented in terms of durability and the possibilities it offered for the inclusion of transparent windows. However, paper manufacturers fought back with new paper formulations and durability enhancements, thus putting a brake on the adoption of polymer. Paper has advantages such as its touch and feel, ease of printing, ink adherence and the ease with which traditional security features such as holograms, security threads and cylinder-mould watermarks can be incorporated.

Combining paper and polymer

When polymer first appeared, *Landquart AG* was a security paper manufacturer supplying paper for the production of banknotes denominated in Swiss francs and other major currencies. The firm considered the possibility of introducing polymer, but sought to do so in a way that allowed traditional security features to be included and without compromising the advantages of paper. In 2006 this idea developed into a concrete plan. The result was *Durasafe®*, a new fully patented standard in the field of high security paper for banknotes.

The concept is simple but unique. *Durasafe®* comprises a three-layer substrate structure. The two outer layers of cotton fibre paper are produced on a traditional cylinder mould. The central layer is a core of special transparent polymer providing mechanical strength and durability, and which forms transparent windows in zones where the layers of paper are cut away with matrixes. In terms of handling, printing and processing, *Durasafe®* behaves similarly to standard banknotes.

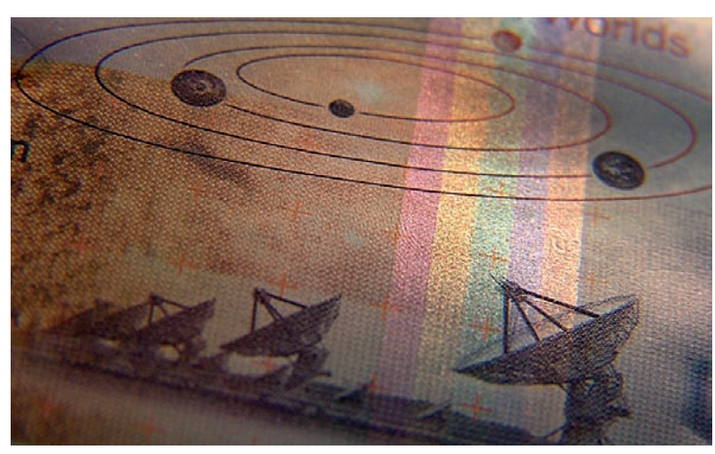
The production process involves a conversion stage in which two reels of cotton-fibre paper are bonded to the polymer layer in an extrusion process under high temperatures and pressure. The hot molten polymer penetrates the microscopic pores of the paper layers before cooling rapidly. The process does not use glue, adhesive or laminated layers, with the result that a firmly bonded compact structure is produced, making it impossible to separate the layers. Windows are created using a cylinder with a matrix module to produce cuts on the main and secondary side of the paper before starting the extrusion process. Each matrix module creates independent shapes. The final substrate, with a 35 g/m^2 polymer core and two 35 g/m^2 cotton paper layers, combines the advantages of the two materials optimally.

The material and processes also offer further unexpected advantages. The unique polyamide used as the core of the polymer substrate has exceptional moisture-retaining properties, and the paper has properties that allow the substrate to adapt well to one and two-sided intaglio printing. Finally, as a waste material, the polymer has similar characteristics to paper, making it easier for central banks to dispose of and minimising the environmental concerns.

Durasafe® and *Viewsafe®*

However, the story does not end here; indeed it has only just begun. One exciting facet of the combination of the advantages of polymer and paper in the paper-polymer-paper structure is the enhanced capacity for security design, using both new and traditional security features. Security features associated with paper (such as security threads, holograms, and cylinder-mould watermarks) can be embedded in the core of the substrate. A transparent window, seen from one side, immediately draws the public's attention towards the encapsulated visible technology. The value for the central bank is obvious when compared with expensive communication and training alternatives. Traditional security features can be used in all denominations. *Durasafe®* encapsulates these visible security features in the window area of higher risk banknotes. The concept is known as *Viewsafe®* and it is changing the way in which banknotes are designed.

Viewsafe® is still a relatively simple product extending the possibilities of *Durasafe®* for banknote substrate design. Traditional visible security features can be added to the secondary paper layer before beginning extrusion. The main paper layer is also cut before extrusion to expose the technologies encapsulated on the inner surface of the opposite paper layer. When the two layers of paper are fused with the transparent polyamide, a transparent window is formed over the security element, leaving it totally visible, but protected behind the polymer core. The *Viewsafe®* window



An example of *Irisafe® Micro* / *Landquart AG*

attracts the public's attention by highlighting the security feature that designer intends the public to use to verify authenticity. It is a simple but extremely effective way of changing how the public habitually performs authentication checks.

Landqart and iridescence

Another new and interesting visible security feature developed by Landqart is *Irisafe® Micro*. This is a distinctive and easily recognisable optical technology which is applied during the final drying stage of paper manufacture. This patented element cannot be replicated by printing. Up to five iridescent colours can be obtained simultaneously, which are laid down as strips in a single process if high precision varnishing is performed. The varnishing allows each colour to be applied individually, achieving perfect registration of the various colours to improve the effect while reducing susceptibility to copying. With the choice of six standard iridescent colours, thousands of combinations are possible and personalised colour codes can be offered to match the specific requirements of each individual customer.

Of course, iridescence is itself a proven method of avoiding copies being made with inkjet printers or even using offset printing. What is more, a simple *Irisafe® Mirco* strip is the perfect means for a broad spectrum of concealed security features, including radio-frequency microchips, which are generally too long to be used with inking processes such as offset or even intaglio.

An additional option is *Polarisafe®*. This feature combines simple ultraviolet fluorescence with a more complex level 2 covert security feature. As well as reacting like ordinary ultraviolet fibres when excited by a standard ultraviolet light source, under a polarised light source, *Polarisafe®* shines or sparkles like stars in the night sky. The molecules of fluorescent ink in *Polarisafe®* pigments are inherently bound to the pigment molecule structure, which produces the sparkling effect. If the note sparkles, it is because of the presence of a real physical particle and not a drop of ink. Fluorescence can be imitated by printing; the *Polarisafe®* effect cannot.

For *Landqart AG* the success of security features should not be considered only in relation to counterfeiting but also in terms of the needs of their legitimate holders. *Landqart AG* technologies have been developed to meet the needs of printers and central bank customers. Designers need a real banknote as the palette for their artistic designs. *Durasafe®* and *Irisafe®* Micro are fully integrated in the design process. *Irisafe® Micro*, like most security features acts inside a *Viewsafe®* window or on the outside of *Durasafe®* or any other banknote paper.

On the outside of the paper, *Irisafe® Micro* can be overprinted with no impact on the banknote design, thus giving ultimate flexibility to the designer. As the technology is applied at the paper mill, printers have maximum scope for creativity. A broad range of combinations and permutations allow each central bank to assign exclusive colour combinations for the country and even for a single denomination.

The *Durasafe®* substrate makes it possible to create virtual window designs on any part of the banknote as the polymer core is transparent and lies beneath the whole paper surface. This gives impressive design flexibility compared with semi-transparent security threads or the patches that are commonly identified with windows. Cutting away the paper layer on either side of the *Durasafe®* structure with a matrix yields the concept of the *Thrusafe®* window. By designing a variety of complex shapes in the cuts, a third totally transparent form is created, superimposed on the cut areas. It does not matter how it has been designed, as the result with *Durasafe®* a totally flexible window.

Landqart AG's strategic commitment

As part of the *Fortress Paper Group*, a publicly traded company on the Toronto stock exchange (TSE X: FTP), *Landqart AG* has recently begun a programme of investment is worth 50 million Swiss francs to raise its capacity to manufacture high security paper for banknotes to 10,000 tonnes. *Landqart's* reputation for professionalism, combined with the company's transparent and public management that sets it apart from the majority of private firms. It is committed to expanding its productive capacity, innovation and reputation for quality, at a time when open and transparent relationships are becoming the norm.

Untitled / JDN

FabrianoDnA: Durable, natural and Authentic

■ **Sergio Antoci** *Fedrigoni SpA*

"Money makes the world go around" and nothing exemplifies the significance of money better than banknote paper. Countless people around the world handle banknotes every day, and banknotes have to withstand all types of environmental conditions, from subzero temperatures, to damp and heat. However, there is no better medium than paper for the features that users associate with banknotes and look for in them, such as watermarks, security threads, intaglio printing, and the touch and feel of paper itself.

A longer life for banknotes

Fedrigoni has met the challenge of extending banknotes' lifetimes without losing their qualities. At its paper mill, which has been a leading producer for centuries, a new banknote paper concept has been developed: *FabrianoDnA* (Durable, natural and Authentic).

Paper reel / Fedrigoni SpA

Fabriano's tradition in paper manufacturing goes back to 1264, and *Fabriano's* expert papermakers' achievements include the invention of the watermark. This craftsmanship has been appreciated over centuries by artists, publishers, intellectuals, mints, banks, and others. For example, an extant document signed by Michelangelo addressed to his friend Nicholas was written on *Fedrigoni* paper. Today, *Fabriano* is part of the multinational *Fedrigoni* group, combining investments in technology and research with history and tradition.

This new paper type has been designed to extend banknote lifetimes, and this is achieved by applying an anti-soiling solution to the paper surface during the manufacturing process. This solution integrates entirely with the natural cotton fibres and is an essential factor in saving energy and extending banknote lifetimes. The use of *FabrianoDnA* does not affect the banknote manufacturing cycle at the printing works, thanks to the high degree of affinity this paper has shown with inks and other security features associated with banknote paper.

The surface treatment applied provides greater protection against the adverse effects of soiling. This has a direct impact on the banknote life cycle and avoids problems when they are used in sorting machines and other electronic devices. Moreover, *FabrianoDnA* improves resistance to damp, making it an ideal paper type for tropical countries.

The defining characteristics of the *FabrianoDnA* substrate are:

- Paper: the substrate is cotton-fibre paper in which the *DnA* solution is embedded.
- Strength: the *DnA* anti-soiling solution gives the substrate greater durability.
- Flexibility: the *DnA* substrate is compatible with all existing banknote printing machines and no modifications to handling and processing equipment are necessary.
- Environmentally friendly: the *DnA* substrate is made entirely in the paper mill machinery without requiring a varnishing process, making it more environmentally friendly than other varnished paper substrates.

Paper manufacturing tradition

All *Fabriano's* paper is manufactured using hydroelectric power and natural gas, and the company holds ISO 14,001 and ISO 9001 quality certificates. This privately owned company manufactures in Europe and sells worldwide, specialising in the production of high-quality, special, adhesive and artistic papers with a high technology content and respect for the environment.

Long-life substrates

■ **Pierre Doublet** *Arjowiggins Security*

A durable and, in particular, soil-resistant substrate for banknote manufacture is of particular interest to Central Banks responsible for issuing banknotes.

The quality of circulating banknotes

Banknotes' condition during their lifetime can be evaluated in terms of their soil resistance and their degree of soiling, how well they retain their print quality and, finally, the mechanical strength of the substrate. Issuing Central Banks are on the lookout for ideal substrates to meet a number of specific needs:

- Security: soiling makes it difficult to check security features such as watermarks and intaglio printing, thus making it harder for the public to readily identify counterfeits.
- Economy: withdrawing banknotes increases Central Banks' costs, as it obliges them to print more banknotes.
- Technical requirements: the paper's loss of stiffness and mechanical strength makes automated banknote handling more difficult and renders banknotes unsuitable for dispensing through ATMs.

Options for enhancing the durability of circulating banknotes

Manufacturers have developed solutions extending average banknote lifetimes. In particular, *Arjowiggins Security* offers two durable substrates:

- ***Diamone®***

This is applied to the paper during the manufacturing process and offers improved ink adherence, and greater resistance to soiling and accidental washing. This improved print stability and enhanced soil resistance extends average banknote lifetimes by 70%. The product comprises a 100% cotton-fibre-based structure, making its appearance identical to that of a paper banknote. There is therefore no change in the security features, print, feel or sound of the banknote. No changes in established handling procedures are required and no modifications need be made to sorting machines. From the economic point of view, this is a cost-effective option because it does not require additional equipment to be used or modifications to be made to the printing process. Moreover, the level of public acceptance is good, because the change is imperceptible and banknote security features can be checked easily.

- ***Diamone® Composite***

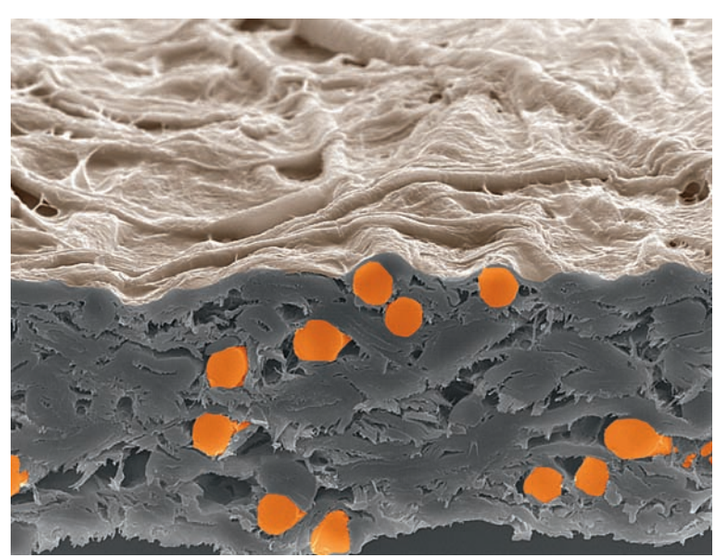
This substrate was developed with the aim of protecting the paper against mechanical deterioration, while conserving the anti-soiling features of *Diamone®*. The surface and composition of the fibres are modified by adding synthetic fibres to the cotton pulp. This produces a paper able to withstand multiple folding and tearing. The synthetic fibres make up between 8% and 15% of the total fibre composition, depending on the desired technical characteristics. This reinforced fibre structure, with enhanced anti-soiling properties, offers a cost-effective solution to counter the soiling and physical deterioration banknotes suffer when in circulation. The average banknote lifetime is substantially extended as treated paper lasts more than twice as long as conventional 100% cotton paper. Banknotes are printed in exactly the same way as with any conventional cotton substrate, without the need for additional processes, and the substrate is fully compatible with all commonly used security features such as security threads and watermarks.

Substrates and health

In its efforts to keep circulating banknotes clean and good quality, *Arjowiggins Security* has gone one step further and taken invisible dirt into account. Microbes are present everywhere and banknotes are no exception, making them potential carriers of pathogens and a route for disease transmission. *Arjowiggins Security* was one of the first companies in the sector to take into account the risk that contaminated banknotes might transmit disease. In this area, it has benefited from its parent company's know-how in the field, in particular its experience deriving from its medical and hospital-related work. Our company has worked with renowned bacteriologists at Lyon Hospital and the *Nosoco.tech* laboratory. The result is the market launch of the *Bioguard®* product, a banknote substrate treatment limiting germ proliferation, making it more resistant to viruses, bacteria and microscopic fungi throughout its lifetime. *Bioguard®* is added to the paper during manufacture, protecting the surface of the paper and its fibre structure against microbes. This product is manufactured from natural materials such that it poses no threat to human health.

Conclusion

Long-life substrates are particularly recommended for low-denomination banknotes, which change hands frequently during their lifetime in circulation. *Diamone®* and *Diamone® Composite* have been used successfully by various public and private printing works, and are currently in use in over 50 countries.



Structure of *Diamone® Composite* / Arjowiggins Security

Extending banknote lifetime

■ **Bridget Taxy** *De La Rue Currency*

Incorporating banknote security features during the initial manufacturing stages by embedding them in the paper offers significant advantages, as these features are then present in the paper throughout the banknote's lifetime. According to *De La Rue*, the combined use of coatings and reinforcement of the mechanical properties of the paper with watermarks can offer an effective and economical solution compared to more expensive paper types containing synthetic fibres or laminated substrate structures. In this article, the firm also presents its own version of a coated polymer for low-denomination banknotes, and a transparent window integrated in a security thread which is inserted during the paper manufacturing process.

Watermarks as a means of strengthening banknotes

Seven years ago *De La Rue* created a technology to boost the mechanical strength of banknotes by adding watermarks to the corners and edges of the paper. This feature has been widely adopted, and it is now incorporated more than 17 billion banknotes around the world. Enhancing the mechanical properties of the paper with watermarks integrated during the process of forming the sheet of paper with a cylindrical mould leverages the process's technological and economic advantages. Forming the sheet of paper is an expensive process to perform, but the added cost of incorporating watermarks during this process is insignificant.

Cornerstone™ was the first watermark structure to be used to reinforce corners. This is an element which increases banknote stiffness by over 50%, significantly reducing the existence of folded corners. Given central banks' quality policy, reducing folded corners significantly cuts the number of banknotes that are unfit for circulation. This characteristic is currently in use by 60 central banks for almost 200 banknote denominations.

Edgestone™ is a recently developed feature which increases the tear resistance of the edge of the long side of the banknote. Tests performed have shown an increase of 30% in the strength of the long side edge of the banknote, matching the figures for the short edge. This feature can be used in combination with *Cornerstone™* to obtain even better results.

Coated paper to protect against soiling

Coated papers are currently the most widely adopted solution to increase banknote durability and, according to *De La Rue*'s estimates, account for over a third of the total paper banknote market. There is a broad range of coating solutions on the market using various different chemicals, and with a varying number of layers and application methods. One example is *Anti Soil Treatment* (*AST™*), which is applied online at the paper mill.

Platinum™ is a varnished paper which has delivered excellent results. An increase in luminosity readings of between 20 and 30% has been measured in laboratory tests, which could represent an increase banknote lifetime of over 50%, depending on the circulation conditions to which the banknote is subjected. To simulate banknote soiling in the laboratory, without needing to perform an external circulation trial, *De La Rue* uses the FIRA soiling test, which measures colour luminosity (L*) at different levels of soiling.

Characteristics of different substrates

	Standard paper	Coatings with reinforced paper	Synthetic fibres	Laminar substrates	Polymer substrate
Tear resistance					
Double folding					
Abrasion					
Soiling					
Relative cost		€	€€	€€€	€€€

Performance of standard paper · Modest improvement · Significant improvement

Combined use of *Edgestone™* and *Cornerstone™* / *De La Rue Currency*

Alternative substrates

The figure shows the results observed when comparing banknotes with different substrates, drawn from various tests performed in *De La Rue's* laboratories.

As the table shows, polymer substrates yield greater durability and may represent the most cost-effective solution for banknotes subjected to intensive use, i.e. banknotes circulating with highest frequencies, under adverse circumstances, and which are returned to central banks relatively infrequently. As standard paper substrate security features are less important in these denominations, polymer may be a cost-effective choice. Polymer has been adopted by many central banks and is used in approximately 8% of all banknotes manufactured.

Against this backdrop, *De La Rue* is developing its own polymer substrate, called *Flexycoin™*, which is an option suitable for low denomination polymer banknotes. It consists of a multilayer varnish on a durable polypropylene core with flexographic printing. The core is purchased from one of Europe's main manufacturers of plastic film and the coating is applied by *De La Rue* at its own works. Security features which can be checked by the public, professional cash handlers and sorting machines can be printed on the banknotes and then protected by post-coating.

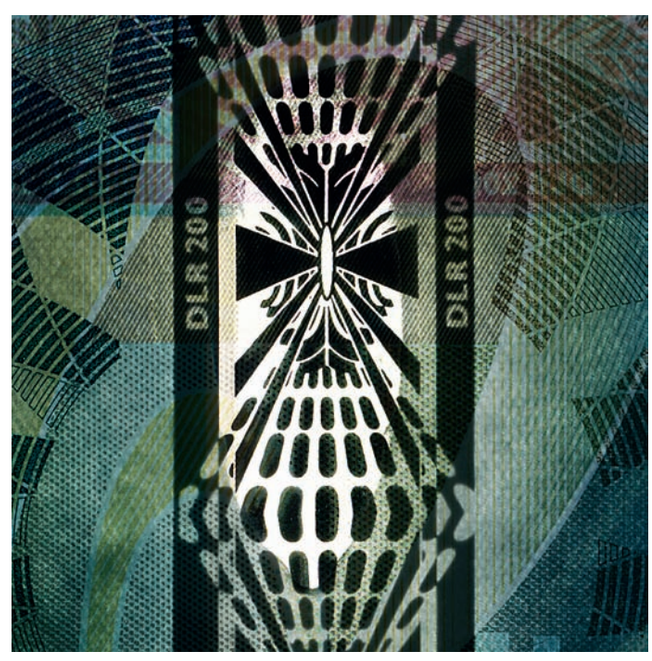
A good design approach integrates low denomination banknotes with other banknotes in the series. To do so, the central bank needs to be able to use the best substrate from each denomination while keeping an attractive series of banknotes in circulation.

A security feature for paper

De La Rue considers paper banknotes hard to beat in terms of security features and has developed *Optiks™*, a wide security thread for high-quality paper banknotes, suitable for verification by the public. This security thread is 18 mm wide and incorporates a moulded transparent window. On the obverse of the banknote the user can see a distinctive see-through decorated transparent window and on the reverse a wide, demetalled security thread. So far, this element has been adopted by nine central banks for use in 17 denominations.

Concluding remarks

Effective solutions exist to strengthen and varnish paper so it meets the mechanical and anti-soiling requirements needed for most banknotes. Polymer substrate is a proven option for low denominations. Nevertheless, other important considerations must be taken into account that influence the choice of substrate, such as cost, security, culture and the quality policy followed by the issuing authority. The choice of substrate must not be a barrier to the design of a banknote family, such that good design allows low denomination banknotes to be integrated with the rest of the banknotes in the series, even though they use different substrates.



Obverse (left) and reverse (right) of a banknote with an *Optiks™* security thread / *De La Rue Currency*

Developing improved banknote substrates

■ **Antonio Olmos** *Fábrica Nacional de Moneda y Timbre-Real Casa de la Moneda (FNMT-RCM)*

In the light of the concern shown by central banks in recent years about the quality of banknotes in circulation and the costs associated with integrated cash management, the FNMT-RCM set out to look for new solutions for these issues. This work led to the development of FLESURE®, a new type of substrate which reduces banknote soiling, and TACTOCEL®, a new tactile security feature, which represents a step forward in terms of adjusting the balance between visual and tactile banknote features which are difficult for counterfeiters to reproduce.

FLESURE®

This is a long-lasting security paper with high mechanical strength and anti-soiling properties, developed by the R&D Department of the FNMT-RCM's paper mill. Its main characteristics are:

- Paper manufactured from cotton-fibre.
- Fibre treatment and special fibre compositions of various types to achieve greater strength.
- Paper coating and/or varnishing.
- Fully compatible with standard security features: watermarks, threads, fibres, holograms, etc.
- Good performance under normal printing processes: maintains conditions necessary for ink adhesion, surface finish improves appearance of offset printing and intaglio line sharpness.
- Allows for different product designs according to customer's needs.

In 2003, the FNMT-RCM addressed the challenge of preparing a banknote substrate with the same security and usage characteristics as traditional paper but with greater strength. It therefore set up a working group bringing together technical experts from research and development, production and the laboratory.

Starting with milled cotton fibre, the fundamental raw material for security paper, the fibres are treated and a special composition prepared combining various formulations of natural and/or synthetic fibres using different specific bonding treatments. The product obtained is a paper offering greater mechanical strength without affecting the application of the usual security features, such as watermarks, threads, fibres, holograms, etc. The new substrate has the added feature that a layer of varnish can be applied to protect it from soiling without this affecting its behaviour in subsequent offset and intaglio printing stages. The aim is to enhance the paper's anti-soiling properties, while maintain the banknotes' tactile features. The photograph above shows the way FLESURE® paper performs better than traditional paper when subjected to soiling tests of the same type as are carried out during the approval process required by one of our customers.

Banknotes subjected to soiling tests: FLESURE® paper (left) and normal paper (right) / FNMT-RCM

FLESURE® has greater mechanical strength than traditional paper and its anti-soiling properties can extend banknote lifetime and keep banknotes in better condition. This is achieved while conserving security traditional security features and with no loss of performance during printing. Indeed, some features are even improved.

This is an evolving product, as the FNMT-RCM is still working to improve its features and adapt it to customer needs. This ongoing work has enabled the varnish application method to be perfected, yielding a series of advantages:

- A more uniform varnish layer
- Better contact between the paper and varnish.
- Perfect adjustment of the layer's thickness.
- Precise setting of manufacturing parameters.

- Online information about fundamental characteristics, such as the percentage of solids, paper weight, moisture content, temperature and drying.

- Quality guarantee.

Moreover, the FNMT-RCM has embarked upon a line of work aimed at translating each customer's specifications into product manufacturing parameters in order to be able to offer a fully customised solution.

TACTOCEL®

TACTOCEL® is a new overt security feature suitable for inclusion in security paper which is capable of a wide range of possible combinations with other anti-counterfeiting features. By using an adaptive relief inserted into the structure of the paper, it meets the important need among the visually impaired to be able to identify banknotes by touch. The technical basis is the incorporation of special components in the paper during the early stages of manufacture. These elements, once incorporated, swell during subsequent stages of paper manufacture when heat is applied to dry the paper, thus giving it these special tactile characteristics.

The implementation uses a cellulose strip as a substrate for the expanding elements. These elements are added to the strip by means of a series of printing processes, allowing the tactile motif to have multiple possible designs and potentially include a whole range of figures, forms and combinations thereof. Moreover, the cellulose strip makes it possible to combine the tactile element with a wide variety of standard security features such as luminous, phosphorescent or magnetic materials. This tactile element is therefore a feature which can be tailored to meet the needs of each individual customer.

The manufacturing process for TACTOCEL® consists of inserting a cellulose strip with expansive agents printed on it into the security paper during manufacture. These agents are part of a special ink which can also include various colours, security features, designs, etc. When heat is applied to the sheet of paper, it expands giving it the characteristic relief. As paper is heated as a normal part of the manufacturing process, no additional process steps are required. The cellulose strip, and the expansion agents it contains, may be included in specific regions within the paper so as to form different figures or legends, and make up various designs or combinations of elements. These elements are located in a strip along the note or a transversal register.

The special characteristics of the expansion agent mean that the relief is able to recover after being subjected to pressure. This means that the feature is entirely compatible with normal paper manufacturing processes. It only requires small adjustments to achieve the proper insertion of the strip, guarantee an appropriate increase in ink and preserve the relief obtained. It is fully compatible with down-stream document printing processes as it does not require special adjustment and does not affect the quality of offset or intaglio printing.

The main advantages of this new product are:

- Flexible design, allowing it to be customised.

- Compatibility with the substrate and other level 1, 2 and 3 security features.

- Integration with the substrate as an additional element of protection.

- Readily adaptable to the current paper manufacturing and printing process.

- Does not affect ink adherence or reduce the speed at which banknotes can be printed.

- Final relief tailored to customer requirements. Thicknesses of up to 150 microns have been achieved, depending on the specific design specifications.

- Collaboration with SICPA on the development of new inks and elements to include in the TACTOCEL® package.

To conclude, TACTOCEL® emerged from a complimentary research line at the FNMT-RCM, which was looking for a novel security feature that was simple, low-cost, easily recognised by the public, while being easy to implement in the manufacturing process and difficult to counterfeit.

Paper manufactured with TACTOCEL® / FNMT-RCM

Mexican banknotes

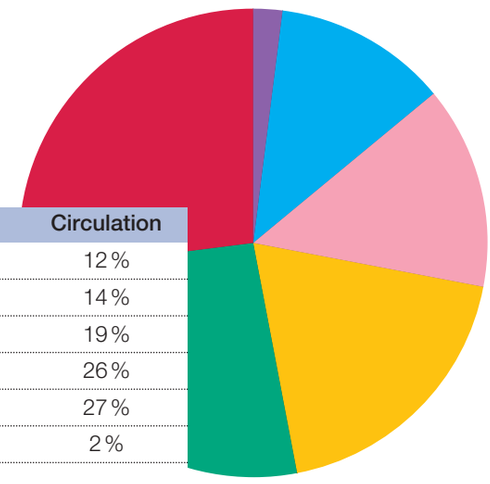
■ **Manuel Galán** *Banco de México*

For over 40 years the *Banco de México* purchased its banknotes from the firm *American Bank Note Co.* However, in the late 60s the Central Bank decided to build a banknote printing works and produce its own banknotes. Thus, in December 1969 the *Banco de México* banknote printing works was opened.

The new series of banknotes

In 2004 work began on the design of a new series of banknotes with the multiple objective of hindering counterfeiting; incorporating features which allowed the visually impaired to identify the denominations in circulation correctly; and utilising the results obtained from the pilot project on the use of polymer for banknotes, run by the *Banco de México* over the period 2002-2004. A method was defined to evaluate all the commercially available elements; the requirements of various cash users were established; interactions were analysed between different security features, costs, the potential for industrial-scale production, the difficulty of using reproduction and counterfeiting, and the ease of use for the public, etc. It was judged necessary for the various denominations of the series to have different sizes, and in particular, that they have different lengths.

Structure of banknotes in circulation



Denomination	Circulation
$20	12 %
$50	14 %
$100	19 %
$200	26 %
$500	27 %
$1,000	2 %

Data from end of 2010

The issue was planned with a timescale of approximately four years as over the period from 2006-2010 the Central Bank also issued two commemorative banknotes to mark the anniversary of the Revolution and Independence. Coordination between the Bank's cash department and printing works was very close. However, when production capacity and stocks allowed, it was decided that some denominations be replaced as rapidly as possible in order to minimise the coexistence of different banknote types. Additionally, a public information campaign was run on television, radio, in newspapers, journals/magazines, on the metro, phone cards, posters, and leaflets, etc. describing the security features of the new banknote series.

Features of the 100 Mexican peso banknote

Design

Issue of the 100 peso banknote began in August 2010. They are manufactured using 100% cotton paper and have dimensions of 66 mm in height by 134 mm in length. The predominant colours are red and yellow.

On the obverse, the main motif is a bust of Nezahualcóyotl, who formed the Triple Alliance between Texcoco, México-Tenochtitlán and Tlacopan around 1431. This same year he was elected Lord of Texcoco, and during his reign he reorganised the government and passed laws strengthening the state. He also ordered the construction of an aqueduct to supply drinking water to México-Tenochtitlán. He governed with prudence and justice and, thanks to his fine writings, is known as the Poet King. He set up various schools for the study of astronomy, language, medicine, painting and history. He was also concerned with the conservation of various species of flora and fauna, promoting the conservation of the woods of Chapultepec.

On the reverse is a vignette of a stylised glyph of Nezahualcóyotl, whose name means fasting coyote or hungry coyote, next to a representation of an aqueduct, the Templo Mayor and the central square of México-Tenochtitlán.

Denominations

As in the case of the preceding series, the new series of banknotes has six denominations: 20, 50, 100, 200, 500 and 1,000 Mexican pesos.

Dimensions

The banknotes include a series of raised geometrical marks, which as well as the different lengths used for each denomination, are intended to make the banknotes easier for the visually impaired to recognise. There is a difference in length from one denomination to the next of 7 mm, starting with 120 mm for the 20 Mexican peso banknote, and so on, up to the 1000 peso banknote, which is 155 mm long. It was decided that all the banknotes should have a uniform height of 66 mm so as not to reduce the productivity of the printing process or affect how they are handled by ATMs.

Substrates

In Mexico, the lowest denomination banknotes are not the shortest lived, because the 20 peso banknote is currently being manufactured from polymer and has a longer duration than the 50 and 100 Mexican peso banknotes. Based on this experience, it was decided that at least the two lowest value denominations (20 and 50 Mexican pesos) should be printed on a polymer substrate, and the rest on cotton paper.

Security features

An in-depth study of the range of security features available was conducted to rule out those considered redundant and select features easily recognised by the public, the aim being to bolster efforts to combat counterfeiting. As a further constraint, it was decided that the cost of the banknote should not be increased by more than 10%.

Printing techniques

- **Offset**. Used for multicolour simultaneous printing of the images on the reverse and to print the background of the obverse, in which some of the colours fade to create an iris effect.

- **Intaglio**. Rotogravure is used to print the main design features on the reverse so as to deposit a thicker layer of ink and so give the banknote relief.

- **Letterpress**. Used to print the banknote serial number in the form of a letter and a seven digit number. The combination of the serial number, the offset printed number of the banknote series, and denomination uniquely identifies each unit.

Security features familiar to the public

- ***Motion* thread** (known in Mexico as a 3D thread). Mexico was the second country in the world to use this feature. Like all its paper-based banknotes, those in this denomination have a windowed security threat with a three-dimensional effect in which the pre-Columbian symbol for a snail can be seen, which is associated with the God of the wind (Ehécatl). The symbol appears to float and move horizontally in and out of the banknote when it is tilted from horizontal to vertical and back.

- **Optically variable ink**. Elements which change colour are printed on all Mexican banknotes. On this banknote, the right area of the corn cob which appears in the top left-hand corner of the banknote is printed with a special ink which changes colour from brown to green when the banknote is tilted at various angles.

- **Watermark**. When the banknote is held up against the light, the bust of Nezahualcóyotl can be seen in the print-free area.

- **See-through register.** Figures are printed on the obverse and reverse in such a way that when the banknote is held up against the light they match up to form an image of the Mexican republic and a wind rose in the top right-hand corner of the banknote.

- **Micro-printing.** All the banknotes in the new series incorporate small text micro-printed in characters of decreasing size.

Statistical data (December 2010)	Mexican pesos	Euros
Value of banknotes in circulation (millions)	666,722	40,290
Average value of banknotes in circulation	238	14.4
Number of banknotes in circulation (millions)	2,794	
Banknotes in circulation per inhabitant	25	
Value of banknotes in circulation as a share of GDP	5 %	

THE 100 MEXICAN PESO BANKNOTE

Note: The number shown beside each of the security features of the 100 Mexican peso banknote refers to the number given to each feature in the "Banknote security features" of the Miscellaneous section of issue 8 of BILLETARIA, where a more detailed description of each security feature can be found.

The *Banco Central de Bolivia*'s Treasury Subdirectorate

■ **Walter Orellana and Abel Sanjines** *Banco Central de Bolivia*

The *Banco Central de Bolivia*'s Treasury Subdirectorate reports to the Monetary Operations Directorate and comprises the Cash Management Analysis Area, which works directly with the Subdirectorate on the Planning of Currency Management, and the Treasury Department, which is responsible for operational tasks. The Subdirectorate has a workforce of 29, who work at the Bank's head office in the city of La Paz.

Organisation and functions

The Treasury Subdirectorate plans, coordinates and manages treasury tasks and operations relating to banknote and coin demand forecasts, stock control and storage, the sorting and distribution of banknotes and coins, and destruction of unfit currency. The Subdirectorate is also responsible for banknote storage and forensic analysis of counterfeit banknotes. In addition, it coordinates the running of training programmes aimed at teaching the public about looking after cash and identifying its security features.

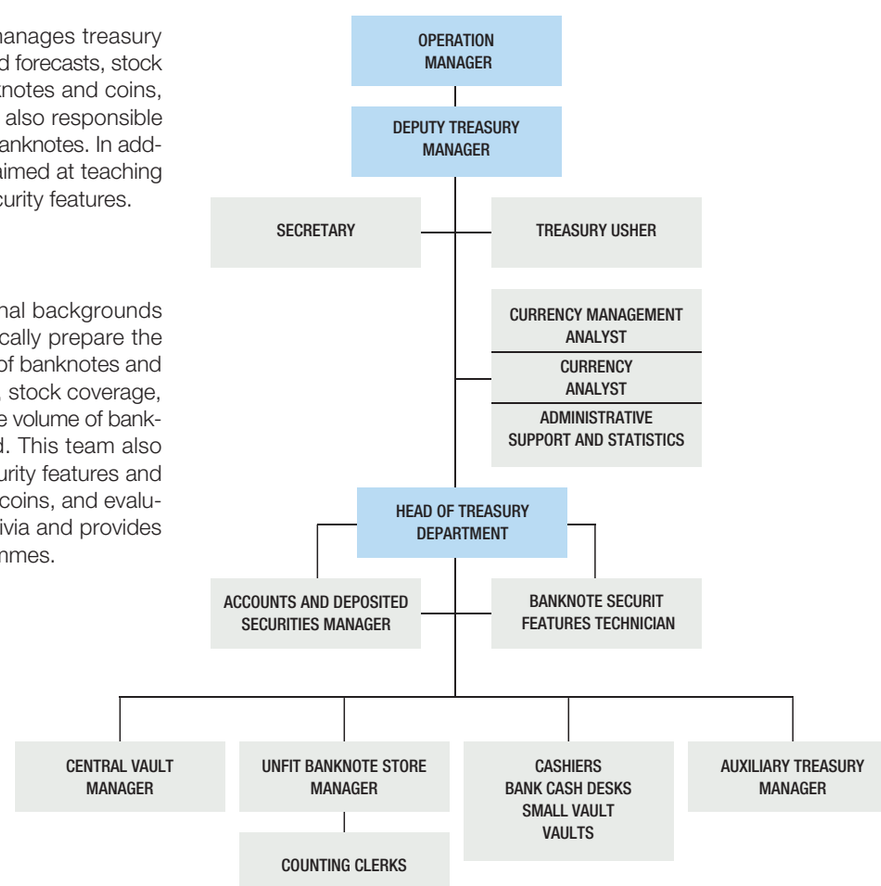
Cash Management Analysis Area

This area comprises a team with a variety of professional backgrounds (economists, physicists, administrators) who systematically prepare the whole range of statistics necessary for the management of banknotes and coins and forecasting banknote durability, cash demand, stock coverage, the volume of banknotes and coins to be procured, and the volume of banknotes due to be destroyed and needing to be replaced. This team also monitors developments and conducts research into security features and the materials used in the manufacture of banknotes and coins, and evaluates the results of the surveys on cash circulating in Bolivia and provides support for the development of public education programmes.

Treasury Department

This department's main functions are the stock control and storage of banknotes and coins, receiving and distributing banknotes and coins, counting and sorting banknotes, withdrawing and destroying banknotes sorted as unfit, and the custody of securities. The Treasury Department comprises:

- An *accounts and deposited securities manager*, who supervises treasury accounting operations and is responsible for the custody and registering of securities.
- *Banknote security features technician,* who analyses, records and classifies counterfeits, issues affidavits and performs forensic analysis of counterfeit banknotes.
- *Central Vault and Auxiliary Treasury managers,* who receive and deliver stocks of the national currency and sometimes US dollars (given that the storage capacity of the central vault is much greater than that of the auxiliary treasury, so it is involved when large sums are moved).
- *Cashiers,* responsible for dealing with the public and the financial system, receiving deposits and making cash payments.
- *Unfit banknote store manager,* responsible for storing withdrawn banknotes and scheduling and carrying out their destruction.
- *Counting clerks,* who are responsible for counting, verifying and sorting deposited banknotes as fit or unfit for financial institutions to put back into circulation.



Headquarters of the Banco Central de Bolivia in La Paz / BCB

The *Banco Central de Bolivia* has developed an IT system exclusive for treasury operations known as the "*Módulo de Tesorería*" (treasury module). This module was implemented in June 2000 and is an automated currency accounting and control system connected to the integrated accounts system. This enables online recording and control of all operations involving cash handling, classifying them by denominations, number of units, banknote condition and physical location (Central Vault, Auxiliary Treasury, Unfit Banknote Store, Correspondent Banks and Savings Banks).

Banknote and coin management

Estimates and forecasts of flows of demand for banknotes and coins are made using econometric models with a three-year horizon. As Bolivia does not have a national mint, estimates are used as the basis for procurement of banknotes and coins through international open calls for tender, which are run in accordance with the country's general rules and standards for the procurement of goods and services.

In view of the significant growth in monetary issues in recent years, as a result of increased demand for the national currency and the stepping up of the "*bolivianisation*" programme, in conjunction with an appreciation of the currency, the *Banco Central de Bolivia*'s storage capacity in La Paz has reached its limits. For this reason, and in order to decentralise cash management, the executive directors of the Bank have approved the construction of an alternative cash handling centre in the city of Cochabamba. The modern new facilities are due to be completed in the next two years.

The *Banco Central de Bolivia* does not have any offices outside the capital. Cash distribution is therefore carried out by financial institutions in La Paz. The annual distribution programme is based on estimated demand and the lifetimes of the various denominations.

Banknote and coin distribution is performed by cash-in-transit companies, charter flights or special convoys of vehicles, and in the case of the transport of coins and low-denomination banknotes (10 and 20 bolivianos) the cost is shared by the Central Bank.

To optimise the distribution of banknotes to the population, as part of its payment system policy, the *Banco Central de Bolivia* has promulgated regulations on the dispensing of banknotes from ATMs, making it obligatory to provide lower denomination banknotes. The aim is to alter the former practice of only dispensing high denomination notes, which was a hindrance for low value transactions in the national economy. To ensure banknotes and coins are exchanged and change is given by financial intermediaries and guarantee that the public is able to obtain smaller denomination banknotes and coins, a specific regulation has been passed establishing the breakdown that must be given to different types of customers and imposing penalties and offering reasonable incentives to encourage financial institutions to comply with this service requirement, which is essential to the smooth functioning of the payments chain.

Quality policy

One of the most important challenges to be tackled in recent years was the need to substantially improve the average quality of the banknotes in circulation. A rigorous scale measuring the degree of deterioration of banknotes has been defined to ensure only good quality banknotes and coins are allowed to circulate. The more rigorous sorting of banknotes, together with the return to financial institutions of badly sorted banknotes, when the error rate exceeds 10%, has made it possible to raise the average quality of the currency in circulation.

The process of counting and sorting banknotes relies on high speed sorting machines, which have had their sensors set to the most demanding standards to match the defined quality scale. It is also worth mentioning that, in parallel, manual counting and checks are performed in the case of banknotes in such poor condition that they cannot be processed by sorting machines.

Destruction of unfit banknotes takes place according to a monthly schedule which is planned annually according to the forecast volumes of unfit banknotes which cannot be returned to circulation and the flow of banknotes that needs to be replaced to ensure the quality of the circulating currency. Unfit banknotes are destroyed using a shredder-briquetter in the presence of a notary, who witnesses that the banknotes have been destroyed and draw up the relevant affidavit.

Finally, it is also worth mentioning that in order to educate the public on how to look after banknotes and check their security features, the *Banco Central de Bolivia* has signed an inter-institutional agreement with the armed forces whereby the latter's units are to provide training in schools and in various social organisations. Last year, these education efforts reached approximately 270,000 people. In the medium term there are plans for the topic to be included on the school teaching curriculum.

Statistical data[1]	2007	2008	2009	2010
Banknotes in circulation				
– Amount	13,660	16,529	18,265	23,837
– Units	208	218	245	319
Banknote payments				
– Amount	---	---	10,901	12,879
– Units	---	---	156	169
Banknotes destroyed				
– Amount	548	688	1,899	2,640
– Units	18	20	49	52

[1]Figures refer to the end of the year. Amounts in millions of bolivianos and volumes in millions of units.

The Eurosystem's efforts in the search for a longer lasting banknote

■ Torsten Meuer and Jérôme Martin *European Central Bank*

Back in 2003, while the majority of the public in the euro area appeared to be satisfied with the quality of euro banknotes, certain National Central Banks (NCBs) began to express their concern over the rapid deterioration in the perceived quality of low denomination banknotes. Taking their analysis of the quality of banknotes in circulation as the baseline, measures were taken to improve the quality of circulating banknotes at national level, in the short term, and at the Eurosystem level, in the medium to long term.

It was a initially thought that significant improvements could only be achieved by increasing the frequency with which banknotes returned to central banks or by enhancing the durability of the banknote substrate. Although increasing the return frequency was hard to achieve, some NCBs had already implemented appropriate measures successfully. Enhancing substrate durability, which could yield cost reductions, was discussed by the Eurosystem, which decided to run trials on longer-lasting substrates. This article describes the activities carried out in this field since 2003 and reports some of the results obtained.

Who's there? / JDN

Substrate selection process

In order to obtain a broader overview of the range of market solutions available that offer improved substrate quality, the European Central Bank invited leading substrate and varnish manufacturers to a joint seminar in May 2003. To evaluate the variety of options for improving durability that were available on the market, together with other alternative substrates under development, two development activity teams (DAP) were set up to examine the two topics separately. In order, to test the available options, two sets of dummy banknotes were designed and manufactured, for low and high denomination banknotes, to which industrial testing methods were applied in order to obtain data for analysis.

During the preliminary selection process, seven different substrates and nine types of varnish were selected as candidates by the first DAP for an analysis of substrate durability, while the second DAP assessed four alternative substrates and two candidate varnishes.

While the DAPs focused on the technical aspects, it was also felt necessary to contrast the results obtained with information drawn from the real-life experience of issuing authorities that had used or tested durable substrates. Thus, in October 2003 a questionnaire was sent to 155 central banks around the world. The responses obtained on banknote lifetime and condition, handling, compatibility with automated processing activity, and rational decision-making policies at NCBs, provided the Eurosystem with extremely useful information. This showed that two thirds of NCBs continued to use traditional substrates, while enhanced substrates were being used by 37% of respondents, of which 43% used varnish paper and 30% polymer substrates. The remainder were using hybrid substrates and other technical solutions. The data concerning potential improvements to lifetimes and costs were analysed, but no firm conclusions could be drawn about extending lifetime. The study's main finding was that information about the public's reaction to new substrates and the experience with equipment compatibility indicated that more issues remain to be resolved in the case of varnished paper than with enhanced substrates.

Durability tests (known, for example, as *Fristsch*, *Turbula* and *Retsch*), evaluated by the development teams, led to the selection of three substrates and two varnishes as the preferred options, given that they presented better performance than the others, especially in terms of soiling. The soiling criterion was considered to be the most important indicator of unfitness,

according to information gathered from Eurosystem banknote processing centres. For each candidate, tests were performed by two different printing works and two independent institutes. The final list of preselected candidates consisted of a polymer substrate, a standard paper with a pre-coating, a cotton and synthetic fibre composite substrate, a standard cotton-paper substrate with an ultraviolet coating, and one candidate with water-based coatings.

Internal circulation test

The objective of the next work programme, known as SUBCOAT II, was to continue subjecting the five preselected candidates to tests. The capacity to produce and handle the selected candidates was tested and a broad range of selection and handling tests performed. Additionally, the range of activities conducted included health and safety, and environmental impact studies.

The results of these tests raised a number of doubts as to whether the results of the laboratory tests were actually representative of how substrates behave in circulation. Prior experience of external circulation tests carried out using national banknotes in countries whose NCBs now formed part of the Eurosystem (for example, the Netherlands) suggested that laboratory tests were incapable of simulating real-life circulation conditions. Given the difficulties of performing external circulation tests with five different candidates, it was decided that an "internal circulation test" initially be conducted. Certain NCBs already had experience in running this kind of trial, and as a result, the existing methodology was adopted.

Four NCBs took part in the trial, forming groups of ten people drawn from among the bank's staff. Each group was given a set of 100 dummy banknotes, in which there was a mixture of candidates and standard banknotes. Each participant was asked to exchange these banknotes a couple of times a day for nine months. After five and seven months 20 banknotes were collected from each group to check their quality. The remainder were examined at the end of the nine-month period. The results of these tests were in some cases significant, showing clear divergences from the results obtained in laboratory tests. In contrast to the results obtained previously, certain candidates did not perform better –or even performed worse– than standard cotton-paper banknotes.

Taking into account all these findings and the results of the various studies, the conclusion reached was that post-coating should be the system chosen to enhance banknote durability, as it had a minimal impact on other characteristics.

The results of the internal circulation test also showed that the choice of an enhanced substrate for low denominations could not be based solely on laboratory results and tests with sorting machines. Therefore, an external circulation test seemed to be the most appropriate way to analyse the behaviour of a group of products under real-life circulation conditions and so to establish a correlation between these results and previous findings. This test could also confirm the average lifetime of the candidates, which underpins the cost/benefit analysis.

External circulation trial

For the trial it was decided that euro banknotes with properties similar to those of standard euro banknotes should be put into circulation. Two different ultraviolet varnishes and two water-based varnish products were used. Before putting the banknotes into circulation, tests were run to confirm that NCBs' sorting machines and third-party equipment could handle them and check their authenticity. Checks were also made to confirm that they had no impact on anti-theft devices or on health and safety.

The trial was run in three countries, which were selected according to size and differing circulation conditions. Trials with €5 banknotes took place in Ireland and the Netherlands, and with €10 banknotes in Portugal. The rationale for this choice was to limit the number of banknotes that needed to be put in circulation. Statistical analysis showed that the test would be a solid basis from which to obtain reliable conclusions after banknotes had been in circulation for approximately 18 months.

Child's play / JDN

The trial was largely successful despite the risks involved. The biggest risk was that the public discover its existence and that the banknotes become collectors' items, or that they circulate in non-random ways, which would have prevented a sufficient number of banknotes returning to the NCBs from which to obtain statistically reliable conclusions. Neither of these problems arose.

The final evaluation and analysis of the external circulation trial had to overcome the difficulty arising from the impossibility of withdrawing all the banknotes put into circulation, as the trial only lasted 18 months (plus a three-month extension). Reasonable estimates were therefore made using a model of banknote circulation and ageing relying on various parameters to estimate the banknote survival function. The statistical results obtained were important and even during the trial it was observed that the candidates behaved in a very similar way in all three countries. When the varnished candidates were compared with the reference banknotes, all the statistical models confirmed the anticipated benefits of varnishing.

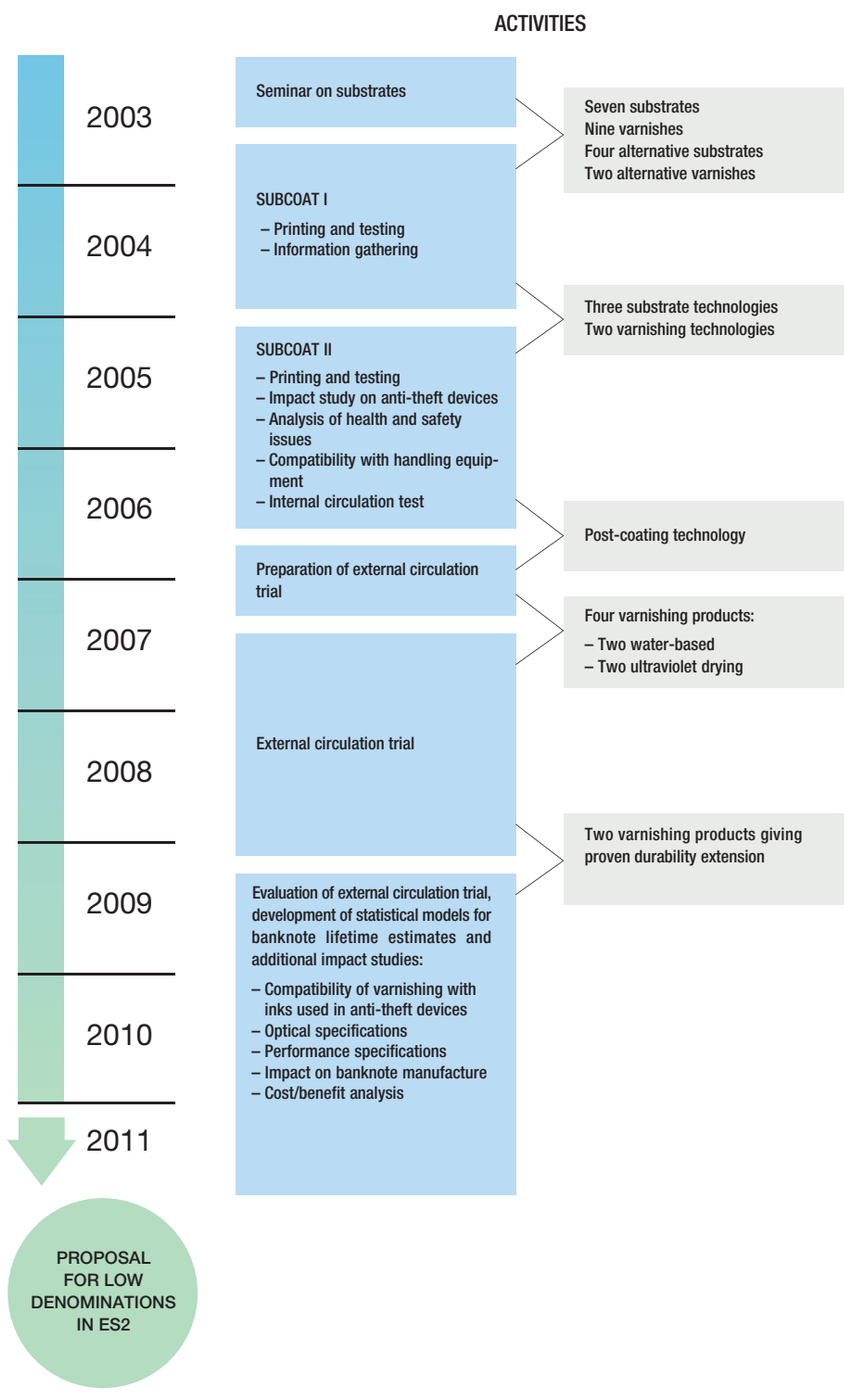
Conclusions

To conclude, the study clearly showed varnishing to offer significant benefits in the case of both products, translating into an average lifetime extension of circulating banknotes of between, at least, 25% to 50% or more, according to the Eurosystem's most optimistic estimates. By contrast, the other two products had little or no effect on banknote durability. To quantify the potential economic savings a cost benefit analysis was performed, from which it was deduced that even after applying the results of the external circulation trial conservatively and prudently to the cost model, varnishing banknotes would produce a significant cost saving for the Eurosystem.

Putting these results into practice satisfactorily will require careful selection and specification of the varnish (and, therefore, finished banknotes) so as to guarantee consistent behaviour over time. An attempt was therefore made to develop a laboratory-based performance test. This could be an empirical soiling test or a combination of various standard tests characterising the varnished banknote. Although various test methods have been studied, none has yet proven entirely satisfactory.

The quest for a more durable banknote substrate for low denominations has led to the final assessment that post-coating is the preferred option for the Eurosystem at this stage. An internal circulation trial was a useful part of the evaluation. Nevertheless, only the external circulation trial enabled the real-life behaviour of the different varnishes to be ascertained. No laboratory test shows the differences in behaviour between the varnishes under real-life circulation conditions, and therefore, no correlation can be established with the results of the external circulation test. To date, no decision has been made on the final specifications of the substrate for the plans to develop and introduce a second series of Euro banknotes (known as the ES2 project). Thanks to the results obtained, several options are now available, and these may be considered by the Eurosystem when the time comes to decide upon the specifications for low denomination banknotes in ES2.

Development of the selection and testing process



Varnishing solutions for a long-lasting banknote

■ **Fernando León and Andreas Walter** *Banco de España* and *Deutsche Bundesbank*

Conventional banknotes manufactured from near-white short cotton fibres (so-called "comber noils"), from the recycling of fabrics in the textile industry and pure cotton fibres are all well established. Today, the next step is to use varnishing techniques to enhance banknote durability and extend lifetimes. This article presents the features of the varnishes used and the current options for their application to banknotes.

What exactly is varnishing?

A varnish is a combination of liquid resins, solvents and additives (wax, adhesive, photo initiator, etc.), which is applied in the form of a continuous transparent ink layer. The varnish, once dry, makes the banknote surface impermeable to soiling. The first varnishes used on banknotes were so-called solvent-based varnishes. Today, after a series of improvements, the following types of varnish are used:

- Water-based.
- Ultraviolet drying (UV).
- Double layer, which can be applied in two ways: i) two layers of water-based varnish, and ii) an undercoat of water-based varnish with a top coat of UV varnish.

Water-based varnishes dry slowly under infrared (IR) and/or warm air. During the drying process, part of the varnish layer originally printed on the banknote evaporates, leaving a final varnish layer that is thinner than the original and almost invisible. UV varnishes are exposed to ultraviolet radiation which causes the particles in the varnish layer to bind and so dry very quickly, such that the thickness of the printed varnish layer is not reduced. In the case of a double layer of varnish, the drying technique depends on the type of varnish used for each of the layers.

The effects of varnishes on the banknote

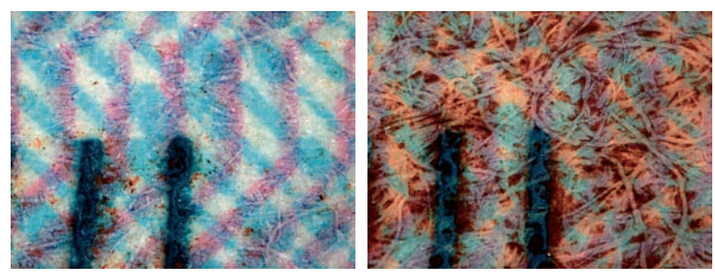
- *Varnishing paper banknotes*

Banknote paper is a porous material which readily absorbs damp, contaminant particles and microorganisms. Varnishing creates a layer protecting the banknote against surface soiling, enabling it to remain in circulation longer. Varnishing is currently used by numerous central banks worldwide, having become one of the solutions available to reduce the cost of cash by extending the lifetime of circulating banknotes[1].

- *Varnishing polymer and hybrid substrate banknotes*

In the case of polymer and hybrid substrates it is necessary to apply any pre-varnish coat in order for the ink to adhere to the substrate. This is followed by a post-varnishing coat to reduce wear on the print during the banknote's circulating lifetime. These varnishes contribute to improving the mechanical and anti-soiling properties of these substrates with respect to conventional banknotes printed on cotton paper.

Table 1 summarises the main results of water-based and UV varnishes.



Varnished banknote (left), unvarnished banknote (right)

Table 1. Comparison of the effects of varnishes on banknotes

Water-based varnish	UV-drying varnish
• Very low gloss	• Low gloss
• Good abrasion resistance	• Very high abrasion resistance
• Does not cause repainting	• Does not cause repainting
• Does not yellow over time	• Instantly drying/dries instantly
• Risk of the sheet of paper stretching or shrinking due to high water content	• Yellows over time
• Risk of lumps of varnish forming due to raised varnish layer	• Can irritate eyes and skin during production processes and banknote sorting

1. According to information from a Eurosystem survey, central banks have issued high durability banknotes using a variety of techniques: 43% have used varnishing (pre- and/or post-varnishing), 30% have used polymer and the remaining 27% have used some other solution.

Varnishing clearly protects against soiling. Nevertheless, the effectiveness of the anti-soiling protection depends both on the type of varnish used and the thickness of the varnish layer coating the banknote. In the case of thin layers, it is worth mentioning that if banknotes are in circulation for a long time surface cracks may appear in the varnished surface, which can collect dirt and so cause dark lines to appear. One solution to this problem is to apply a double coat of varnish (see Table 2).

A comparison between different varnishes

There are four possible options for varnishing banknotes:

1. Varnishing the substrate
2. Varnishing the banknote after printing (post-varnishing)
3. Applying two layers of varnish to the banknote
4. Varnishing with two layers, one applied to the substrate and the other to the banknote after printing

Table 2. Comparison of the different varnishing options

	Pre-varnishing at paper mill	Post-varnishing at printing works	Dual varnishing at printing works	Dual varnishing at paper mill and printing works
Costs	+	++	++	++
Equipment requirements	Reel varnishing machine	Varnishing machine with a unit for each side of the banknote	Varnishing machine with two units for each side of the banknote or using a two runs process	Reel varnishing machine and varnishing machine with a unit for each side of the banknote
Anti-soiling efficiency	Considerable	Good	Optimal	Optimal
Adherence of hologram to substrate	Improved	No effect	No effect	Improved
Visual impact	None	Minimal	Minimal	Minimal

Is it possible to detect that a banknote has been varnished simply by looking at it?

Generally speaking, varnishing can be applied to banknotes without the need to make any modifications to their design and security features. However, checks always need to be made to ensure that varnishing does not affect visual aspects of the banknote or its machine readable features.

UV-varnish tends to be glossy whereas water-based varnish tends to be matte. The glossiness of a varnish can, to some extent, be modified by the manufacturer so as to minimise its impact and avoid its interfering with the appearance of banknote security features such as, for example, holograms and colour-shifting optically variable inks. The influence of varnishing on machine-readable features is minimal, however.

Does varnishing interfere with automatic banknote sorting?

The gloss produced by varnishing must be kept below certain limits or otherwise it might interfere with the cameras capturing the banknote image during quality controls in sorting machines at the printing works or with the optical sensors in the sorting machines employed by central banks to sort used banknotes.

It is worth pointing out that varnishing does not interfere with quality control devices or sorting machine sensors if the same type of varnish is used on all the banknotes sorted by the machines. However, if more than one type of varnish is used, it may raise banknote reject rates, given the impossibility of calibrating the sorting sensor to recognise several types of varnish at the same time. Likewise, the sorting of varnish and unvarnished banknotes together should be avoided to prevent a significant increase in the banknote unfit rate during the sorting process.

Production aspect and commercial availability

Flexography is the technique best suited to applying varnish to the banknote, as it enables a uniform layer of varnish to the surface of the whole banknote sheet. Optimal anti-soiling protection is achieved from varnishing if the process is applied after all printing processes, including numbering, have been completed, so as to cover all the areas of the banknote surface, both printed and unprinted. The flexographic printing technique is used both for water-based and UV-drying varnishes.

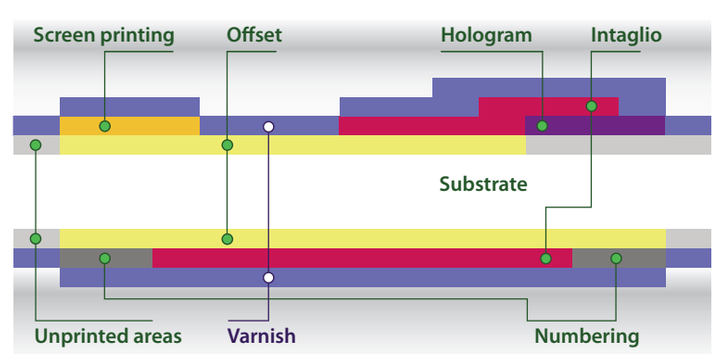
For example, the process whereby a single layer of UV varnish is applied in a single run is a highly standardised solution for banknote varnishing. This process allows a standard varnishing machine to be used, which has a varnishing unit for each side of the banknote. The thickness of the UV varnish layer produced is 2-2.5 g/m^2, which ensures adequate anti-soiling protection for banknotes under normal circulation conditions.

Two-layer varnishing at the printing works is another alternative option. The first layer of varnish, which is water-based, adds a thickness of approximately 1 g/m^2 to the paper. It adheres strongly to both sides of the paper and offers a good surface for printing on. The second layer is a UV varnish, which gives a thickness of approximately 2 g/m^2 and provides good anti-soiling properties. Dual varnishing must be performed on both sides of the banknote and cover the whole surface.

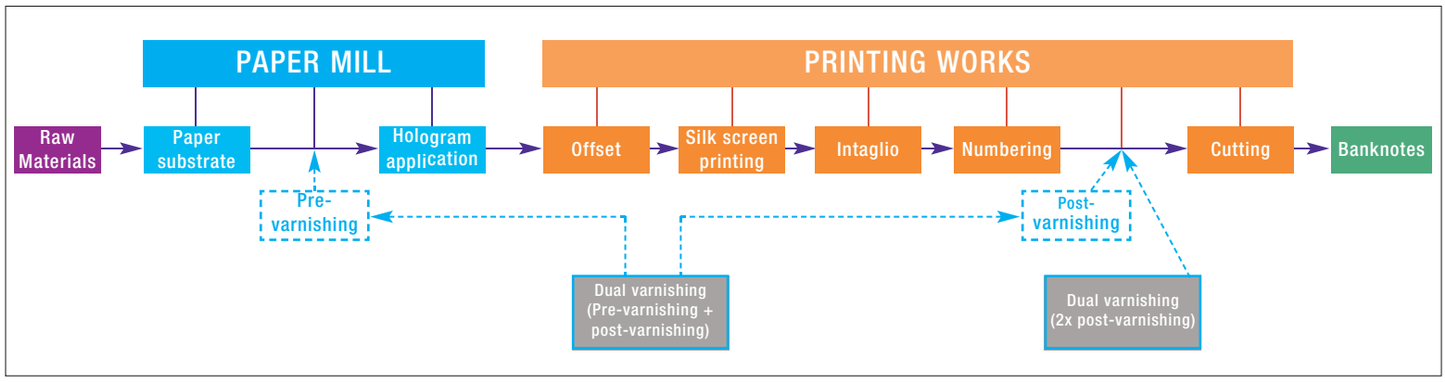
An alternative to the two-coat varnishing processes is to apply the first coat of varnish at the paper mill and the second layer at the printing works, at the end of the printing process.

Finally, it is worth mentioning that both the varnishes and the machinery used for the varnishing process are widely available on the market, with a variety of suppliers of each.

Schematic representation of the thickness of a varnished banknote



Schematic diagram of the banknote manufacturing processes



Summary

Banknote varnishing is today a mature solution widely used by central banks. Protecting the surface of banknotes with a varnish layer has proven to be a cost-effective way of achieving the goal of extending the lifetime of banknotes in circulation. Various varnishing solutions exist, each with different characteristics and effects. Banknote varnishing therefore appears to be an effective and efficient solution if a series of requirements are met, such as optimising banknote protection against soiling, minimising the impact of gloss on its visual appearance, minimising differences in touch and feel compared to unvarnished paper, avoiding problems in the use of sorting machines and the distribution of banknotes through ATMs, and, of course, presenting a favourable cost benefit analysis.

(continued from page 29)

Analysis of substrates by the *Banco de México*

200 Mexican peso banknote on high-durability paper. Obverse (left), reverse (right) / *Banco de México*

varnish coating on the banknote after printing (post-varnishing) is the solution yielding the most durable result.

- High durability paper substrates are printed in the same way as conventional paper. Applying the varnish coating after printing requires an extra manufacturing step.
- The security features of conventional paper are also suitable for high-durability paper types. Post-print coating has to be avoided in areas with security features which include lenticular structures.
- Post-printing varnishing processes with varnishes from different suppliers can result in differences in appearance.
- Migrating from traditional paper to high durability paper and/or varnishing banknotes after printing is simple as there is no need to redesign banknotes or adjust equipment, or to run advertising campaigns.

Analysis of substrates by the *Banco de México*

■ **Enrique Guarner** *Banco de México*

Some years ago, with a view to reducing costs and optimising cash management, the *Banco de México* decided to change its banknote substrate so as to extend the average banknote lifetime. In order to be able to draw conclusions about the pros and cons of each substrate based on practical experience, the new policy has relied on both laboratory tests and a limited issue of banknotes using the substrate being tested. Banknotes have been tested in this way using polymer substrates, high durability papers and paper to which post-printing coatings have been applied.

The traditional cotton-paper substrate

As a substrate, cotton paper has delivered excellent performance over the years. However, the inclusion of new security features with a new range of physical properties affects how paper behaves during the production process, reducing productivity. Moreover, banknote substrate suppliers have developed different types of high-durability paper and polymer substrates. The *Banco de México* therefore conducted laboratory and circulation tests using various types of substrate to substitute for conventional paper.

Table 1 sets out the main specifications the *Banco de México* requires from suppliers of conventional paper, polymer and high-durability paper.

Table 1. Main specifications for conventional paper, durable paper and polymer

Specification	Conventional paper	Durable paper	Polymer
Material	100% cotton	100% cotton	BOPP
Weight	92-94±3 g/m²	96±3 g/m²	82±8 g/m²
Thickness	122±8 microns	122±8 microns	88±7 microns
Tearing*	83 g-f	83 g-f	20 g-f
Double folding*	2,100	2,100	10,000
Crumpling*	10	12	24
Rubbing*	150	160	300
Soiling resistance tests performed at the Banknote Printing Works.			

* The figures represent the minimum number of double folding, crumpling or rubbing operations the substrate samples withstood. Tearing strength is shown in grams of force.

Polymer substrate

In 2002 the *Banco de México* replaced its 20 peso paper banknote with one printed on a polymer substrate. Before taking this decision, large-scale industrial production was tested, and a trial of the banknotes' performance in circulation and durability was run. At the time there were print durability concerns about colour intaglio printing on polymer, so the image was printed using offset with transparent ink intaglio. As regards the paper banknote, the only changes were to certain aspects of the design so as to create room for intrinsic polymer features. Moreover, as polymer has limited resistance to tear propagation, an advertising campaign was run to discourage people from stapling banknotes together.

Circulation tests indicated that polymer banknotes achieved an average lifetime that was 2.8 times longer than that of a conventional paper banknote. Moreover, studies of public perception indicated a high degree of acceptance. However, alongside these advantages, there was the problem that when banknote bundles were cut open with a sharp implement, many units were torn. The *Banco de México* therefore changed its bundle-wrapping procedure to tackle this drawback.

The 20 and 50 peso banknotes in the current series are also printed on polymer using transparent ink intaglio incorporating the new *G-switch*® feature, with optically variable ink and a transparent window. It is worth noting that the number of counterfeits of the new 50 peso banknote fell substantially (by approximately 10%) compared to the previous banknote.

Moreover, in 2010, 50 million units of the 100 peso banknote printed on polymer were issued to commemorate the centenary of the Mexican Revolution. Laboratory tests have shown good adherence by the colour intaglio ink.

High-durability paper substrates

Banknote durability analysis

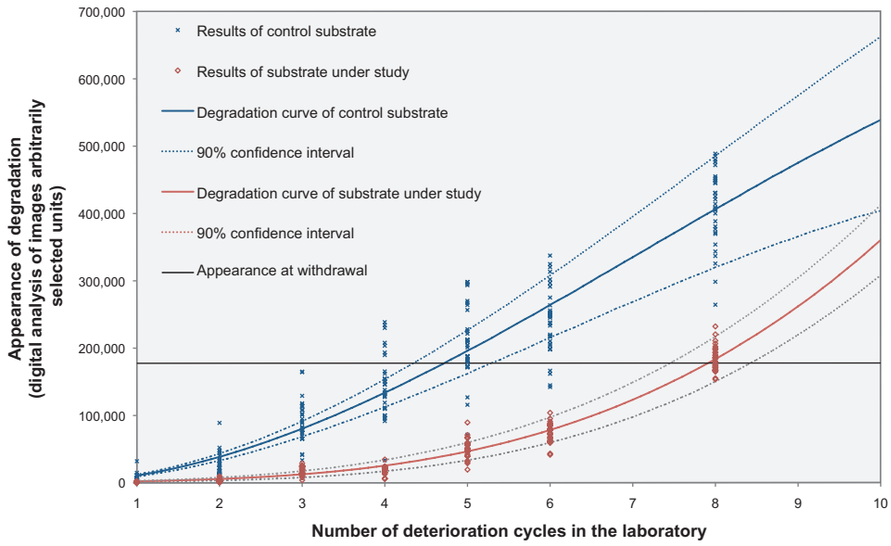
The market currently offers various types of high-durability paper. Some of them contain a mixture of natural and artificial fibres, others include anti-soiling surface treatments and other paper types are manufactured with a combination of these features. There are also various types of varnishes which may be applied as a coating after banknote printing.

Given that circulation tests are costly and time-consuming, the *Banco de México* ran a series of laboratory studies to determine what features might improve banknote durability. A new methodology was developed to obtain estimates of the average increase in banknote lifetime based on the following two assumptions:

- It is sufficient to compare the appearance of a banknote with that of a new one to assess the extent to which it has deteriorated.
- Measuring banknote deterioration requires the construction of deterioration curves with a wide interval of levels of banknote degradation.

The graph shows the results of banknote deterioration analysis based on evaluating changes in appearance and using degradation curves prepared by the *Banco de México*. The laboratory study reveals that the high-durability paper coated with a varnish after printing yielded a considerably longer lifetime than conventional paper. No results are yet available regarding circulation as the trials are still in progress.

Digital analysis of degradation by evaluating appearance



Paper substrates analysed and results obtained

The features of the high-durability paper types analysed by the *Banco de México,* and the results obtained relative to the expected increase in the average life of each banknote, are shown in Table 2.

Table 2. Final results of the tests with various paper types

Substrates	Code	Fibre composition	Anti-soiling treatment	Varnish coating	Average lifetime
Conventional paper	A0	100% cotton	No	No	---
	A1	100 % cotton	No	Yes (1)	29 %
	A2	100 % cotton	No	Yes (2)	12 %
High durability	D0	cotton + artificial fibres	Yes	No	10%
	E0	100 % cotton	Yes	No	33 %
	F0	100 % cotton	Yes	No	38 %
	G0	cotton + artificial fibres	Yes	No	5 %
	H0	100 % cotton	Yes	No	34 %
	E1	100 % cotton	Yes	Yes (1)	69 %
	F1	100 % cotton	Yes	Yes (1)	87 %
	H1	100 % cotton	Yes	Yes (1)	86 %

(1) Post-varnishing of banknote with varnish from supplier A
(2) Post-varnishing of banknote with varnish from supplier B

The conclusions obtained from the laboratory tests were as follows:

- Varnishing the substrate increases average banknote lifetime.
- Pre-varnishing increases banknote lifetime by between 10% and 38%.
- Post-varnishing increases banknote lifetime by between 12% and 29%.
- Dual varnishing (pre + post varnishing) increases banknote lifetime by between 69% and 86%.

Adding artificial fibres to the paper substrate does not improve banknote durability, although it does increase the banknote's mechanical strength.

Circulation test with a commemorative 200 peso banknote printed on durable paper

In 2008 the *Banco de México* decided to issue 50 million units of a 200 peso banknote printed on high-durability paper, commemorating the 200th anniversary of the country's independence. Manufacturing and circulation tests were performed on various types of high-durability paper, some of which were coated with varnish after banknote printing.

Four types of paper substrate were used. Each type accounted for 25% of the total:

- Conventional cotton paper.
- Conventional cotton paper plus a varnish coating on the banknote (post-varnishing).
- Varnished conventional cotton paper (pre-varnishing).
- Pre-varnished + post-varnished conventional cotton paper.

Except for minor differences, the notes using the four different substrate types looked the same. The durable paper types performed well at the printing stage and there were no problems with varnishing printed banknotes.

Although it is still too early to fully assess the durability of these substrates, with the information obtained in the laboratory tests and that gathered so far from the real-life circulation test using the commemorative 200 peso banknote, the *Banco de México* has taken the decision to print the normal circulation 200 peso banknote on a pre-varnished paper substrate and apply a post-varnish coating to the banknote after printing.

Conclusions

Polymer compared to conventional paper

- Adjustments are required in the origination and production processes, but there are no critical problems which cannot be resolved with experience and by adjusting the processes.
- Banknote printing productivity when using a polymer substrate is equivalent to (or even better than, in the case of some processes) that of paper.
- The wrapping of polymer banknote bundles is a very important issue and the use of sharp-edged tools must be avoided when opening the bundles as a small scratch in a polymer banknote can result in its tearing completely.
- In laboratory tests, intaglio printing polymer banknotes with colour ink gives a similar result than with transparent ink.

High durability paper compared to traditional paper

- IThe high durability substrate comprising an anti-soiling treatment applied to conventional cotton paper (pre-varnishing) complemented with a

(continued on page 27)

The *Bank of Thailand's* experience with high durability banknotes

■ **Sopee Sa-nguandekul** *Bank of Thailand*

The Thai issuing authority has put in place a policy aimed at guaranteeing that the banknotes in the public's hands are in good condition. Injecting more new banknotes into circulation and withdrawing soiled notes is a simple way of achieving this objective, but implementing this approach is very expensive. Banknote issue and management need to be guided by cost-effectiveness, but the issuing authority has to focus on overall costs, including the cost of banknote issue, handling and procurement. In order to keep costs down, the *Bank of Thailand* has reduced demand for new banknotes by extending their lifetime by issuing high-durability banknotes. It is crucial that the issuing authority have the opportunity to experiment with new types of banknote substrate which may extend their lifetime.

The search for high-durability banknotes

The *Bank of Thailand* investigated several durable substrate technologies and reached the conclusion that polymer would be the most appropriate solution for its banknotes, in view of its greater physical strength. In 1996 it issued two banknotes using the polymer substrate for the first time. These were a commemorative 500 baht and 50 baht banknote, and they were well received by the public. Subsequently, a non-commemorative 50 baht polymer banknote was issued in order to better estimate the performance of the new substrate throughout its lifetime in circulation. Since 1998 polymer banknotes have been printed at the *Bank of Thailand's* printing works and 486 million 50 baht banknotes have been put into circulation.

A detailed nationwide opinion survey carried out in parallel showed the preference for polymer banknotes among the general public, cashiers, professional cash handlers and retail banks to be low. It was observed that, in practice, the new banknotes' resistance to wear and tear was reduced by the fact that the intaglio printing came off of the polymer as a result of the rubbing and folding the banknotes suffered while in circulation. Moreover, it was found that many banknotes were deformed by folding and shrank when exposed to high temperatures. These two factors were the main reasons for banknotes becoming unfit for circulation. Once folded or shrunk, polymer banknotes could not be restored to their original shape, rendering them unfit for automated processing.

As an alternative to the polymer substrate, paper manufacturers developed a new type of durable banknote based on 100% cotton paper incorporating a varnish and anti-soiling materials. This substrate looked very promising, as it offered clear advantages over the polymer substrate. Its look and feel was the same as that of a banknote manufactured from conventional paper, and therefore, the public's perception and acceptance was not affected. Moreover, it retained all the security features of banknotes produced with standard paper, without being subject to restrictions on folding and heat exposure. Laboratory simulation tests also showed banknotes printed on durable paper to have enhanced soiling resistance. Moreover, no special equipment was needed for their manufacture and they produced better quality results from intaglio printing.

Developing a soiling resistance test

In Thailand, soiling is the main cause of banknotes being sorted to unfit. Therefore, the search for a new banknote substrate has focused on those alternatives which are best able to repel soiling while the banknote is in use. Making a precise estimate of a banknote's lifetime in circulation is extremely difficult, and it can take years to record and evaluate the real circulating lifetime data for different types of durable banknote. This being the case, a laboratory test could provide useful results. Against this backdrop, the *Bank of Thailand's* Printing Works developed a soiling resistance test to simulate the soiling of banknotes in circulation under experimental conditions in its laboratory as a means of determining their relative levels of soiling resistance. A mixture of artificial soiling agents was prepared in the form of clay balls stained with soy oil, olive oil and ethanol. The balls were loaded in a container together with the banknotes and it was rotated so that the balls acted like the fingers of a hand touching and staining the banknotes. This procedure has been developed and standardised to make it equivalent to the real conditions of banknotes in circulation. The results of this test have made it possible to evaluate the performance of various different high durability substrates.

Circulation test on durable banknotes

Following our research into durable paper substrates, we concluded that it offered better soiling resistance than standard paper. However, ink adher-

ence was poorer, because the substrate was designed not to attract dirt. The new ink formulations have been developed to improve ink adherence properties.

Physical properties of durable paper compared with standard paper con el papel estándar

Properties	Standard paper	Durable paper
Weight (g/m^2)	83	85
Thickness (mm)	108	114
Crumple porosity, 8X (ml/min)	Max. 190	Max. 120
Washing resistance[a] (index)	Min. 3	Min. 3
Crumpling resistance[b] (index)	4-5	4-5
Soiling resistance[c] (index)		
• Banknote paper (30 minutes programme time)	2/3	3
• Printed paper (30 minutes programme time)	2/3 – 3	3/4 – 4
• Printed paper (60 minutes programme time)	2/3	3 – 3/4

Notes:
a) and b) index of 1-5 in accordance with standards used by the *Bank of Thailand* Printing Works, where 5 indicates excellent resistance, 3 is acceptable and 1 is very low.
c) Index of 1-5 according to the grey scale to measure soiling, ISO 105-A03, where 5 indicates excellent resistance, 3 is acceptable and 1 is very low.

In 1999, the *Bank of Thailand* decided to run a controlled circulation test with this type of durable substrate by issuing 40 million 20 baht banknotes printed on the selected durable substrate and an equal number of banknotes printed on standard paper. These banknotes were put into circulation in the North East of Thailand, the region where banknotes suffer the harshest circulation conditions. Given that the two types of banknotes looked identical, it was possible to run the durability study without changing the usual banknote sorting processes, simply by monitoring monthly withdrawals of banknotes from circulation and the percentage of unfit banknotes. The upshot was that the durable-substrate banknotes were found to last an average of 1.7 times longer than those printed on standard paper. After two years in circulation, it was concluded that the average lifetime of durable banknotes was between 70 and 80% longer than the standard equivalent. The cost increment due to use of the substrate rather than conventional paper was 30%.

Transition to high durability banknotes

The positive results obtained from the circulation test with 50 baht banknote led the *Bank of Thailand* to undertake, a step-by-step transition to the durable substrate for all its banknote denominations. This began with the issue of 500 baht banknotes in 2001, followed by the 20 baht banknote in 2003, 100 baht in 2004 and the 1,000 baht banknote in 2005.

To accredit paper suppliers' ability to manufacture the specified type of durable paper, it was necessary to define the standard for soiling resistance in line with the method developed by the Central Bank's Printing Works. As some types of durable paper can be longer-lasting than others under harsh circulation conditions, research was conducted to improve the soiling resistance and physical properties which could influence banknote strength. Consequently, the *Bank of Thailand* decided to raise the level of soiling resistance and some physical properties with a potential impact on banknote lifetime.

The next step

Substrate suppliers continue to develop new types of durable substrate using various technologies, such as high strength fibres, banknote varnishing, laminar substrates with a polymer layer, etc. The search for a better durable substrate solution is an unending road. Bearing in mind that the high demand for circulating banknotes is influenced by banknote durability, the *Bank of Thailand's* research into durable substrate is ongoing in order to achieve greater overall efficiency in both manufacture and issue.

Obverse of banknotes after soiling resistance tests: durable paper (top) and standard paper (bottom) / *Bank of Thailand*

Obverse of 500 baht commemorative banknote / *Bank of Thailand*

Tests on long-life paper

■ **Ana María González and Diego Schweckandt** *Banco Central de la República Argentina*[1]

Published reports on banknotes and accrued experience show the most common reason why banknotes are withdrawn from circulation to be soiling. Other reasons included physical damage, scribbles, wear and tear, and the loss of effectiveness of certain security features.

In recent years, in order to improve the strength of conventional paper and offer the market more durable substrates, a number of leading banknote manufacturers have developed types of cotton-based paper with certain special features. In order to evaluate the durability characteristics of these products, standardised laboratory tests were performed to compare them with the paper used for banknotes in the Republic of Argentina. These included tests of mechanical strength, print durability, and soiling resistance.

The samples analysed presented the following basic characteristics:

Table 1. Characteristics of the samples

Samples	A	B	C	D	E	Current paper
Type	Paper with anti-soiling treatment					Conventional
Weight	90.0	87.0	93.0	97.0	91.0	90.0
Fibre composition	100 % cotton	80 % cotton 20 % polyester	100% cotton	80% cotton 20 % polyester	100 % cotton	100 % cotton

Tests performed

Mechanical strength. The mechanical tests performed on banknote paper are intended to reproduce in the laboratory some of the strains that banknotes are subjected to during their lifetime in circulation. The tests examine the *paper's tensile strength and resistance to folding and tearing*.

Soiling resistance. In order to simulate the treatment of banknotes in circulation, samples were crumpled in an NBS Crumpling Device. Subsequent tests then examined banknote *porosity after crumpling, soiling (both using a unit known as the TURBULA and by directly applying a variety of substances), and water absorption (Cobb method*).

Print durability. Printed paper samples were subjected to tests of their *resistance to chemicals and crumpling.*

Main findings

Table 2. Main results of mechanical resistance tests

Resistance	A	B	C	D	E	Current paper (*)
Tearing (gf)[1]	84	123	89	153	91	89
Dry traction (kN)[2]	6.9	6.3	7.0	6.5	6.2	6.8
Moist traction (kN)	3.2	2.8	5.3	5.2	2.8	2.7
Double folding	4,268	5,411	2,081	7,211	2,684	5,274

1. gf: grams force 2. KN: Kilonewton / metre

Note: Due to the differences in the weights and specifications of the different paper types, the results are not strictly comparable.

Table 3. Average values from the tests performed

Sample	Uncrumpled (*)	Crumpled (*)
A	24.8	22.1
B	26.1	24.3
C	24.9	24.5
D	24.1	25.4
E	25.1	25.8
Current paper	30.5	28.7

(*) Difference in whiteness (before and after treatment)

Table 4. Results of print crumpling resistance and washing tests

PAPER	CRUMPLING (4: excellent; 1: poor)		WASHING (5: excellent; 1: poor)
	DRY	MOIST	
A	4	4	3
B	3.5	4	2
C	3	4	4
D	3.5	4	5
E	4	4	1
Current paper	4	3.5	2

Final remarks

- Paper types containing synthetic fibres presented better mechanical strength in tear and double-fold tests.
- Special paper types performed better in soiling tests, with an increase in soiling resistance of between 15 % and 20 %.
- The results of print durability tests were practically the same for all paper types, or slightly better in the case of special paper types.

1. This article does not aim to present the definitive opinions or points of view of the *Banco Central de la República Argentina* on the subject of the study.

8th International Course on Cash Management

The International Course on Cash Management (CIGE) was created by the *Banco de España* in conjunction with the *Banco de México* and the *Banco Central de la República Argentina*, and its first edition took place in 2004, in Madrid. Since then, each year the CIGE has been held at the headquarters of one of the founding central banks (*Banco de España, Banco de México* and *Banco Central de la República Argentina*) or at the headquarters of a central bank in Latin America that has expressed an interest in hosting it. So far, these have included the *Banco de la República de Colombia*, the *Banco de Portugal* and the *Banco Central do Brasil*. The table below gives an overview of the last four Courses for comparison. The 8th CIGE will be held in Lima, Peru, from 2 to 6 May 2011, under the auspices of the *Banco Central de Reserva del Perú* as host for the event. The theory and practical sessions comprising the Course will cover all phases of the cash cycle, looking at all the activities of a central bank, and workshops and visits to cash centres are planned. As on previous occasions, the organisers have made considerable effort to ensure the Course maintains a high professional standard and that teaching is of the best academic quality. All central banks in Latin America, Spain and Portugal have been invited to send a participant. For more information, please contact:

Table comparing recent Courses

Edition	4th CIGE Banco de la República 10-14 September 2007	5th CIGE Banco de Portugal 26-30 May 2008	6th CIGE Banco de España 1-5 June 2009	7th CIGE Banco Central do Brasil 17-21 May 2010
Venue	Bogotá	Lisbon	Cercedilla (Madrid)	Rio de Janeiro
Countries participating	18	12	18	18
No. instructors	16	19	24	16
No. lectures	14	14	20	20
No. round tables	4	6	4	3

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Periodical publications on cash

■ **Editorial Committee of BILLETARIA** *Banco de España*

Annual international conferences and meetings on cash offer interesting lectures, studies and other contributions and are an extremely useful source of knowledge for professionals in the banknote and coin field. However, specialist publications on the subject are scarcer and often hard to find. This note aims to give an overview of some of the specialist periodical publications in our field available in Europe in print format. We should, however, make clear that this list does not aim to be an exhaustive catalogue –a lengthy task beyond the scope of his work. We have therefore not included publications only in circulation outside Europe's borders, or catalogues of banknotes and coins, advertising brochures or web-based publications, nor have we covered the numerous documents and papers by central banks that are not published periodically.

The accompanying table summarises the main characteristics of the publications mentioned. These fall into two groups: periodicals offering general information, and newsletters published by associations or firms in the currency industry. All these publications can be looked up on their publishers' websites. The more general periodicals are mostly produced by public-sector organisations. The remainder, published by private firms, tend to focus primarily on the products their sponsors are promoting and marketing, and are distributed free of charge to their customers and any other interested parties.

Generalist publications

1. From Central Banks: free of charge and without advertising

BILLETARIA focuses on cash management and is prepared by the Cash and Issue Department of the *Banco de España*. It is produced by central banks for central banks. It is characterised by its offering opinion articles by leading Central Bank professionals and by firms involved one or other of the phases of the cash cycle. It also presents interviews with key figures in the cash management world. There is a particular focus on Latin American countries and the journal reports on the International Course on Cash Management (CIGE), which was the initial impetus for the creation of BILLETARIA, and which is run each year by the *Banco de España* in collaboration with Latin American central banks. The journal is published twice a year in Spanish and English.

Boletim Notas e Moedas is a newsletter from the *Banco de Portugal's* National Counterfeit Centre. It basically comprises institutional information on cash management and the Bank's communications policy. It also presents a compilation of the most significant cash-related statistics in Portugal. It therefore publishes data on banknote and coin circulation, euro counterfeits detected in Portugal, euro-relevant legislation and includes a world-

wide numismatics section. It also reports on training courses and materials existing to help users recognise euro banknotes and coins. The contributors are almost exclusively from the *Banco de Portugal,* although there are occasional exceptions. The journal is produced every four months and is published in Portuguese.

2. By other publishers: not free of charge and include advertising by their sponsors and others

Banknotes of the world. News bulletin. This is a publication from the Russian firm *Intercrim-Press*. The publisher was created on the initiative of the Russian Federation's Interior Ministry in December 1999 in order to provide information about counterfeits in circulation in Russia and in other countries of the former Russian Federation. As well as the monthly publication it produces an annual catalogue of banknotes in circulation around the world. The newsletter specialises in banknote security features and counterfeiting, with images of new banknotes put into circulation worldwide. Each issue of the journal generally includes an article on new technology developments with banknote applications. Although the publisher produces most articles in-house, articles by experts from the banknote world are also sometimes also published. Published monthly in English and Russian.

Currency news, from the British publisher *Reconnaissance International Publishers and Consultants*, to accompany the *Currency Conference*, an international forum which brings together banknote experts from around the world every 18 months. It specialises in interviews, news and events, reporting on new developments, and occasionally includes opinion and analysis pieces on the currency world. Articles are not usually signed by their authors, except those taking the form of an interview. Published monthly.

Watermark is a journal created by the Ministry of Finance of the Russian Federation, the *Central Bank of Russia* and the manufacturer *Goznak*. The editorial board includes experts from central banks in Russia, Byelorussia, Ukraine, Kazakhstan, Armenia, Kirghizstan and the security-document industry. The publisher is the organiser of the *Watermark Conference*, an international meeting dedicated to security-document printing. The content of the journal includes interviews, technical articles, new features and a list with photographs of the main banknote security features. It sometimes also publishes opinion articles by experts in the field. It is published twice a year, in April and October.

Specialised publications

1. Devoted to banknote production and sorting

This heading includes those publications devoted to banknote design, substrates, printing, and manufacture and equipment for cash handling and sorting. The range of topics also sometimes includes articles on banknote distribution and custody. These journals and brochures report on trends and new developments, as well as the technology available for the production and sorting of banknotes. Generally speaking, they are published once or twice a year. The publications in this section include Banconota, Exchange, Interact, IPCA BULLETIN and Report, and The G&D Magazine.

2. Publications devoted to security

These are specialist journals or brochures on security features for valuable documents, thus covering a broader spectrum than solely banknotes. In the currency field, the bulk of content concerns anti-counterfeiting measures, the technology available and new developments underway regarding banknote security features. Articles are usually written by in-house authors, and are unsigned. All these periodicals are published between two and four times a year. This group includes CONFIRMA SEGURIDAD DOCUMENTAL, INFOSECURA and Security Update.

We hope the information compiled here will be of interest to BILLETARIA's readers. The listed publications can be accessed via the relevant publisher's website in each case. And, to finish, we would like to add that we hope to see the number of publications increase in the future with a view to fostering an increasingly fruitful exchange of experience and know-how between cash professionals around the world.

Looking at the red coat / Y. Barrera

		Name	Publisher	Specialist field	Content	Regularity	Remarks
Generalist Publications	Central Banks	**BILLETARIA**	Banco de España.	Central bank cash management, with a Latin American focus.	Interviews, opinion and technical articles.	Six-monthly, in April and October.	• Information and statistics. • In English and Spanish. • Free. • No advertising.
		BOLETIM NOTAS E MOEDAS	Banco de Portugal.	Cash at the Banco de Portugal.	Institutional articles, legislation, counterfeiting.	Four-monthly: January, May and September.	• Information and statistics. • In Portuguese. • Free. • No advertising.
	Other publishers	**BANKNOTES of the World News Bulletin**	Intercrim-Press.	Banknote security features.	Technology and counterfeiting in Russia and the countries of the former "Russian Federation".	Monthly.	• In English and Russian. • Not free. • Includes advertising.
		Currency News	Reconnaissance International Publishers and Consultants.	Currency Conference.	Interviews, news, trends and events.	Monthly.	• In English and Spanish. • Not free. • Includes advertising.
		WATERMARK	Watermark Ltd.	Valuable document security features, with a particular focus on Russia and countries of the former Soviet Union.	Interviews, technical articles, new developments.	Six-monthly, in April and October.	• Not free. • Includes advertising.
Specialist publications	Banknote production and sorting	**Banconota**	KBA Giori.	The publisher's products.	Banknote technology, design, production and sorting.	Six monthly: spring/summer and autumn/winter.	• In English. • Free. • No advertising.
		Exchange	De La Rue.	Banknotes and equipment manufactured by the publisher.	Technology, design, development and trends.	Annual, spring.	• In English. • Free. • No advertising.
		Interact	Talaris.	Current news in the cash world, with attention on banking institutions.	IT systems, equipment and banknote security.	Six-monthly: summer and winter.	• Currency conference. • Spanish. • Free. • Includes advertising.
		IPCA BULLETIN	International Polymer Currency Association.	Technology for the manufacture of polymer banknotes.	New technologies and features and issues of polymer banknotes.	Intermittent.	• In English and Spanish. • Free. • Includes advertising.
		Report. The G&D Magazine	Giesecke&Devrient.	Design, production and manufacture.	Technology, news, articles, trends.	Last issue in 2008.	• In English, German and Spanish. • Free. • Includes advertising.
	Security	**CONFIRMA SEGURIDAD DOCUMENTAL**	SIGNE, S.A.	Security printing.	Technology and protection against counterfeiting of valuable documents.	Four-monthly: January, May and September.	• In Spanish. • Free. • No advertising.
		INFOSECURA	Intergraph.	Security in printing of valuable documents.	Technology and development of banknote security features.	Quarterly: January, May, July and September.	• In English. • Free. • Includes advertising.
		Security update	KABA.	Design and security products from the publisher.	Automation, security and controls, with a particular focus on cash.	Six-monthly: June and September.	• In English, German and Spanish. • Free. • Includes advertising.

Central banking news

Estonia joins the Euro

Since January 2011, euro coins and banknotes have been in circulation in Estonia, bringing the number of countries in which the euro is legal tender up to seventeen. The changeover went smoothly, thanks to ample stocks of banknotes and coins in shops and ATMs on the launch date, as euro banknotes and coins had been frontloaded and sub-frontloaded to financial institutions and retailers beforehand. Estonian kroons continued to circulate in parallel up until 14 January, which was the start for the period during which the public can exchange their Estonian kroons at financial institutions free of charge. This window closes at the end of the year, although the old currency can be changed at the Estonian Central Bank indefinitely. An advertising campaign, including a series of television commercials, was run to inform and educate the public and professional cashiers about the new currency, thus enabling the message to reach a large percentage of the population.

New Brazilian 500 and 100 *real* banknotes

The new 500 and 100 *real* banknotes, in the second generation of *reais*, came into circulation on 13 December 2010. It is envisaged that the new 20 and 10 *real* banknotes will be launched in 2011, and the 5 and 2 *real* banknotes in 2012. The planned second generation of *reais* banknotes aims to modernise the *real* banknote series using sophisticated graphics to raise the bar significantly for counterfeiters. The new banknotes have been designed with a different size for each denomination and incorporate tactile marks to facilitate their identification by the visually impaired.

The new banknote design retains the image of the *Efígie da República* symbolising the Brazilian republic on the obverse, and has images of Brazilian fauna on the reverse.

Obverse of the new banknotes / *Banco Central do Brasil*

The new banknotes also include security features that are readily identifiable by the public, including the holographic foil strip and latent image. The two series of banknotes will coexist in circulation until the new banknotes have replaced the existing ones. Users will not need to exchange their old banknotes at financial institutions.

New European Regulation on coins

In December 2010 ***Regulation (EU) no. 1210/2010, of the European Parliament and of the Council concerning authentication of euro coins and handling of euro coins unfit for circulation*** was passed. This new European regulation establishes the procedures and standards credit institutions and other economic agents are required to comply with in order to guarantee the authenticity of coins received from the public which they intend to put back into circulation. These requirements were imposed by Regulation (EU) no. 1338/2001 of 28 June 2001, laying down measures necessary for the protection of the euro against counterfeiting. The text also defines a series of obligations on Member States concerning cooperation, control and supervision.

The new Regulation supersedes ***Commission Recommendation 2005/504/EC, of 27 May 2005, concerning authentication of euro coins and handling of euro coins unfit for circulation***, which established the recommended practices for the authentication of euro coins and the processing of euro coins unfit for circulation. The new Regulation will come into force on 1 January 2012.

To summarise, the main obligations established for institutions are: 1) authentication of all the coins they receive and intend to put back into circulation using coin processing machines authorised by the European Commission or by personnel trained in accordance with modalities defined by Member States; 2) all euro coins unfit for circulation and suspected counterfeit coins detected during authentication are to be submitted to the designated national authority, and 3) information on the euro coin authentication activities conducted is to be sent periodically.

The Regulation also defines new obligations for Member States, namely: 1) they are to provide manufacturers with the possibility of performing detection tests on their machines, and 2) they are to make annual on site checks at institutions with a view to verifying the proper functioning of the processing machines used and to confirm the existence of a written policy providing instructions to ensure the obligations are complied with.

This new regulation on coins, together with the ***European Central Bank* Decision (ECB/2010/14) of 16 September 2010, on the authenticity and fitness checking and recirculation of euro banknotes**, completes the common guidelines implementing Regulation 1338/2001, aimed at ensuring the authenticity and fitness of euro banknotes and coins.


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(Legislative acts)

REGULATIONS

REGULATION (EU) No 1210/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 15 December 2010
concerning authentication of euro coins and handling of euro coins unfit for circulation

Germany changes its coin handling practices

The *Deutsche Bundesbank* has modified its provisions for the acceptance and withdrawal of coins. The change is included in the context of the measures implemented to standardise the packing of coins in rolls, and requires that coins be authenticated before they are returned to circulation. Since January 2011 coin deposits and withdrawals are only permitted in the form of complete coin containers. These coin containers are specific to each denomination and have a capacity which varies from 200 to 500 packs of ten standard rolls. To allow the market to adjust to the new requirements, for a charge, part-filled containers will also be accepted during a transitional period.

Standardised coin container / *Deutsche Bundesbank*

Events

Central bank GS1 standards users meet in Madrid

On 10 March 2011 the second meeting of the group of European central banks using GS1 standards for cash activities was held. The meeting was organised and hosted by the *Banco de España*'s Cash and Issue Department in conjunction with the Central Banks of Germany, France and Italy, which have also adopted these standards. Representatives of the business and IT areas of various Eurosystem Central Banks considering using GS1 were also present, as were officials from the *European Central Bank* and various European GS1 organisations. Issues concerning the implementation of these standards in national cash cycles were covered, and the standards will undoubtedly contribute to raising the efficiency of cash distribution. The conclusions reached at the meeting included the organisers' declaration of their intention to promote the use of standards at all stages of the cash cycle in their respective countries, and facilitate their adoption by other countries outside the Eurosystem that have expressed an interest.

Attendees of the GS1 meeting in Madrid / BILLETARIA

ICCOS EMEA meeting in Spain

From 20 to 23 March 2011, the city of Barcelona hosted the second Regional Conference of ICCOS EMEA (Europe, Middle East and Africa). This conference is a forum for debate on methods and practices to increase efficiency in the cash cycle. Representatives of the various sectors concerned took part in the event, along with delegates from the Central Banks of the United Kingdom, Germany, the Netherlands, Austria, Belgium, Spain and the *European Central Bank*. The topics covered included the cash management and the cost of cash, the regulation on cross-border cash movements, the recirculation of banknotes and coins, training, and anti-counterfeiting efforts. Representatives of credit institutions, cash in transit firms, the vending machine industry, and commercial associations also took part. Participants were welcomed with an address by J. Darío Negueruela, Director of the Cash and Issue Department at the *Banco de España*.

Participants at the ICCOS EMEA meeting in Barcelona / ICCOS EMEA

Security features integrated in banknote paper

■ **Banco de España** *Cash and Issue Department*

As issue 9 of BILLETARIA is devoted to paper substrates, this section presents the main overt banknote security features that can typically be included in them. The guiding principle has been to include those features generally supplied by the paper industry already incorporated in the substrate. However, we have also included some elements, such as threads and holographic foils, that are security features in their own right and independent of the substrate used, thus meriting a section of their own. The features described have been classified by common functional traits retailers or the public can detect by eye or using simple equipment. The list combines security features that have traditionally been included among those incorporated in the paper of the banknote and those latest generation features that are starting to appear in the most recent banknote issues around the world.

WATERMARKS

1. Multi-tone watermark
This consists of an image that is visible when the banknote is held up against the light, which is created during the manufacturing process such that it is an integral part of the paper. It is made by varying the thickness of the paper to produce differing degrees of opacity, resulting in the lighter and darker areas which make up the image.

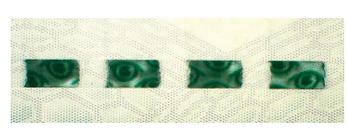
2. Electrotype watermark
This is an image that is visible when the banknote is held up against the light. It is created during the manufacturing process using a filament which takes the shape of a number or letter.

3. Duotone watermark
This is a type of watermark in which two clearly different shades can be distinguished when the banknote is held up against the light. These cover a relatively large area, similar to a binary code or bar code. This type of watermark is produced during paper manufacture using a mould to vary the thickness of the paper so as to produce the visual effect.

SECURITY THREADS

4. Embedded security thread
This is a thin strip of plastic inserted in the paper. It is usually 1-2 mm wide, and 30-40 microns thick. It is often has microtext printed on it and may be fluorescent. It may also have electrical or magnetic properties to enable it to be read by banknote handling equipment.

5. Windowed thread
This is a slightly wider strip than the embedded security thread (3-4 mm), which weaves in and out of the paper. The areas not covered by the paper are visible and may contain an optically variable feature, such as an ink which changes colour when the banknote is tilted. Inserting a windowed thread in the paper is associated with the production of a watermark, which may act as a further security feature in its own right when the banknote is observed against the light.

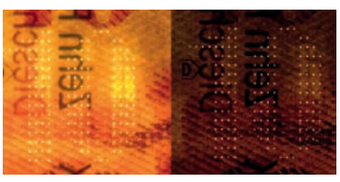


6. Thread with floating images
This is a windowed thread which is inserted into the paper using standard techniques. The floating image effect is produced by micro-lenses incorporated in the thread. Changing the angle at which the micro-lenses are viewed by tilting the thread produces the impression that the images are floating.

OPTICALLY VARIABLE FEATURES

7. Hologram strip applied directly to the substrate
This is a metal strip running across the whole width of the banknote on which there are holographic motifs, diffractive zones and optically variable features that change when the banknote is tilted. This is normally applied with horizontal registration, although the latest trend is towards its vertical registration to ensure that the motifs are at the same distance from the top edge in all banknotes.

8. Transparent security window
This is a transparent area of the banknote obtained by cutting away part of the substrate and into which elements with various optical effects are incorporated. These may include embossed plastic laminates, liquid crystals, or an optically variable feature. The window can have whatever morphology is required in order to match the design of the optical element to be applied to it.



9. Micro-perforations
This is an image formed by countless minute holes in the paper which is visible when held up against the light. The perforations are made using a laser.

TACTILE FEATURES

10. Crisp sound
The characteristic sound made when a banknote is waved in the air. Cotton paper gives the banknote its crisp sound and gives banknotes their characteristic stiffness and feel.

11. Raised embedded features
These are particles embedded in the paper which contain components that expand them and create a high relief tactile surface. The particles are inserted attached to a strip which is laid between two layers of paper during manufacture and which can be used as a vehicle for other security features, such as fluorescence. There is no limit on the shape of the designs these raised embedded elements allow for.

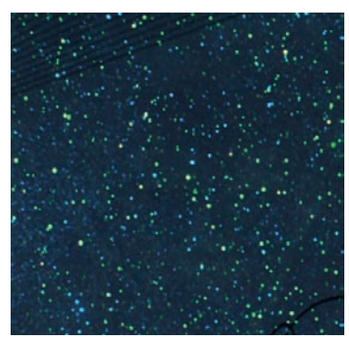
PAPER COLOUR

12. Tinted paper
The application of inks or pigments to the paper so that, in conjunction with the other paper additives, the finished product takes on a specific hue. The colour of the paper is usually the same tone as the dominant colour of the images on the banknote itself. Normally pale tones are used, which are difficult to reproducing using electronic copying techniques.

ULTRAVIOLET PROPERTIES

13. Absence of optical brighteners
The paper substrate used for banknotes does not respond to ultraviolet light, which differentiates it from most commercially available paper types.

14. Fluorescent fibres
This features comprises fluorescent fibre fragments, normally of plastic, embedded randomly in the substrate matrix. These fibres fluoresce under ultraviolet light. They may respond in several colours, usually green-yellow, red and blue. They are normally between 3 and 6 mm long.



15. Planchettes
These are tiny circular or polygonal elements, usually made of paper or plastic, which are scattered randomly across the surface of the paper substrate. They fluoresce when the paper is examined under ultraviolet light. They usually have a yellowish-green response, but as with fluorescent fibres, other colours are possible (see element 14). They usually have dimensions of a few millimetres.

16. Multicolour fibres
These are coloured fibre fragments, normally made of paper or plastic, embedded randomly in the paper substrate. Each fibre shows two or more colours, usually yellow, red and green, when examined under ultraviolet light.

World map by Domingos Teixeira, 1573.
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