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# Editorial

■ Manuel Galán *Banco de México*  
 ■ J. Darío Negueruela *Banco de España*

BILLETARIA is back, keeping its regular appointment with all its readers, and in this case with a special focus on some of the key experiences and developments seen in the use of a polymer substrate for banknotes. The intention, in this respect, is to offer a broad view of a key topic to ensure that BILLETARIA becomes an important point of reference for professional cash handlers.

A number of attempts to use alternative substrates for banknotes were first made in the early 1980s, but it was not until the late 1980s / early 1990s that Australia, using new technology and the Guardian substrate, became the first country to issue a complete series of polymer banknotes.

Since then the number of countries using the polymer substrate has gradually increased: there are now more than 15 billion polymer banknotes in circulation in 27 different countries. Interestingly, the reasons for the changeover to polymer vary considerably: the stated aims include increasing the lifetime of the banknotes and keeping them cleaner for longer, enhancing security by reducing counterfeiting and cutting operating costs. However, whatever the reasons for the changeover, there is virtually complete agreement on the distinct advantages offered by the polymer substrate.

The decision regarding which banknote substrate to use, like almost all the decisions we face in cash-related matters, is not an easy one. There are advantages but there are also disadvantages, and at the end of the day the decision will depend on how much importance each central bank assigns to each of the different factors. Nevertheless we believe, on the back of recent experience, that irrespective of whether or not they choose to adopt a polymer substrate for their banknotes, central banks around the world have benefited from the existence of this alternative substrate as, in addition to offering a different solution to cash managers, it has acted as a catalyst, triggering changes and significant improvements in the paper and traditional substrates industry and in traditional security features.

Our thanks go, as always, to all those who have made possible this issue of BILLETARIA by sharing their experiences with us. The articles by the Reserve Banks of Australia and New Zealand, the Banco de México, the Banco Central de Chile, the National Bank of Romania, the State Bank of



Vietnam and the Banco Central do Brasil provide a balanced view of this question, reflecting their different experiences in the use of polymer. We trust you will find them interesting.

This issue of BILLETARIA also includes our regular sections, starting with the "interview" in which we talk to Manuel Castelhana who was, until just recently, Head of the Treasury and Issue Department of the Banco de Portugal and who gives us the benefit of his wide-ranging experience in human resources management, communication and all cash-related matters.

In the Banknotes and Coins section, the Banco Central do Brasil presents the key features of its banknotes, with special focus on the 20 real note, the Banco Central de Reserva del Perú provides a detailed overview of the structure and functions of its Currency Management Directorate, and the Banco de España presents a summarized guide of the characteristics of the euro commemorative coins issued by the European Member States of the Economic and Monetary Union.

The polymer theme is resumed in the Cash Activities and Technology section, but in this case from the point of view of manufacture of the raw material and of the banknote printing process, with articles that describe how polymer is made and the peculiarities of polymer versus paper in banknote production.

Lastly, we would like to thank all our readers for their interest and their time in connection with the survey we included in our last issue. We received replies from 37 countries where the review is distributed and the opinions expressed represent a highly valuable source of information for us: they provide an insight into your views of the publication and your preferences for certain topics, and they also act as a catalyst for continued improvement. We thank you, once again, and we trust you enjoy this latest issue of BILLETARIA.

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# Interview with Manuel Castelhana, former Head of the Treasury and Issue Department of the Banco de Portugal

■ J. Darío Negueruela *Banco de España*



Manuel Pimentel Castelhana graduated in Sociology from the *Instituto Superior Económico e Social* of Evora and holds a postgraduate in the Sociology of Portugal from the New Lisbon University. His professional career began in 1973 in the Portuguese Ministry of Employment where he held the posts of Head of Division and Director of Human Resources. In 1984 he joined the Banco de Portugal as Technical Coordinator of the Training Centre. He then moved to the private sector, working between 1987 and 1989 in one of Portugal's leading consultancy firms.

In 1989 he returned to the Banco de Portugal to undertake large-scale organizational and personnel restructuring and in 1990 he was appointed Director of Human Resources Management and Development. In 1993 he was appointed to the Commission entrusted with establishment of the Carregado Complex. Ten years later, in 2003, he became Director of the Treasury and Issue Department and assumed representation of the Banco de Portugal on the Eurosystem Banknote Committee. In 2005 he was made a member of the Board of Directors of the Valora printing works. He also combined his professional role with teaching activities: between 1975 and 1980 he taught classes in Sociology, Management, Planning and Health and Business Administration, and between 2000 and 2002 he taught on the Master's in Project Management at the *Instituto Superior de Engenharia* in Lisbon.

*By the time this issue of BILLETARIA reaches you it will be almost four months since Manuel Castelhana left the Treasury Department of the Banco de Portugal after a long and distinguished career in the public sector. We asked him to give us the benefit of his experience on some of the key issues in the world of banknotes today.*

*I first met Manuel Castelhana in 2003 when he was appointed Director of the Treasury and Issue Department of the Banco de Portugal and became a member of the Eurosystem Banknote Committee. A man who at first seemed shy and cautious was soon to become a loquacious friend with an extraordinary gift for the spoken word and a prodigious imagination. Manuel has a constant awareness of people, an ever-present sense of strategy, priority and responsibility and a view of the future from which one can always learn. For all these reasons, and as a friend, I am pleased and proud to be able to introduce him here to you today.*

*In our conversation, Manuel Castelhana touches on a number of important questions affecting both the present and the future of Treasury Departments, from a highly personal, original and in my opinion enriching*

*point of view. He draws on his experience as Director of Human Resources to remind us of the singularity of that "very particular and strong subculture within Treasury Departments" and highlights the importance of being "a good strategist and organizational architect...". He also underlines the need to draw a clear distinction, inter alia, between productivity, effectiveness and efficiency, concepts that in some cases can lead to confusion. Manuel then goes on to discuss the future challenges facing the Treasury and Issue area and the need to work on a new management model to define our future role in the cash cycle. And he concludes by recommending that we keep our articles in BILLETARIA short and sharp, so we shall heed his advice and move on to the interview.*

**Q. Manuel, can you give us a brief description of your professional experience in the Banco de Portugal? Is there any difference between working in the Treasury Department or in any other central bank department? Does Treasury have any peculiarities?**

**A.** My professional career was essentially split between the Ministry of Employment and the Banco de Portugal, over a period of some 40 years. I spent two-thirds of this total at the Banco de Portugal, first in Human Resources where I assumed a range of tasks, including Head of Department for some 14 years, and subsequently, as from 2003, in Treasury and Issue.

Indeed, these areas are very different: Treasury and Issue is more attractive, partly because it has more concrete goals and its activities are to a large extent related to manufacturing and are therefore more controllable, but especially because there is a certain aura surrounding money. It is strongly rooted in society, but also, for all the obvious reasons, within central banks.

The professional profiles and values are also different. For example, people not connected with this area have no idea how important values such as safety, rigour, confidence and quality are for Treasury professionals. This leads us to conclude that there is a very particular and strong subculture within central banks.

**Q. In your opinion, what is the best management profile for a Treasury department? An expert in industrial and business areas, an economist to control costs or a generalist? Do you believe your expertise in sociology-related issues was useful in your role in the Treasury and Issue Department of the Banco de Portugal?**

**A.** It is not easy for me to be impartial on this matter. Clearly some technical knowledge is important for a good strategist and organizational architect in the Treasury and Issue area, but I do not believe it is essential. Moreover, it all depends on the conditions, resources and competences that one has at one's disposal. A manager should be more of a vision builder and a promoter of ideas, driving and channelling the energy available to meet the challenges and goals set.

As regards the appropriateness of my basic training, one cannot deny that it falls to a large extent within the scope of human resources. However, in any management role, people are a manager's first and ultimate challenge: they are what makes a company exist; they are its number one



Manuel Castelhana (left) and J. Darío Negueruela (right).

success factor. Accordingly, I experienced no special difficulties in this respect. And I would add that in the latter part of a career, with some 30 years' management experience, basic training has little impact on performance. Professional experience and knowledge are more important than basic training, without a doubt.

**Q. The Treasury and Issue Department of the Banco de Portugal is based at the Carregado Complex on the outskirts of Lisbon. This Complex includes the Valora printing works, the vaults, the banknote processing centre and the staff offices of the Treasury and Issue Department. What are the advantages and disadvantages, if any, of having a Treasury department located on the outskirts of a major city?**

**A.** As Director of Human Resources, I was part of the Commission that set up the Carregado Complex, although when the Commission commenced its task the process of purchasing the land for the new cash centre was already complete. In my view, however, it was an excellent choice.

The Carregado Complex is a modern, functional and secure facility that is still, even today, a reference point among Eurosystem cash centres. It is located approximately 40 km (or 25-30 minutes) from Lisbon, close to Portugal's principal road network. Accordingly, it not only offers excellent access and service conditions to credit institutions and cash-in-transit companies, but it also permits fast fund transfers to and from the Banco de Portugal's Agencies. Moreover, the fact that Valora operates at the Complex represents a clear advantage from the point of view of logistics and security.

**Q. Central banks use different strategies to make the production and supply of cash to the economy more efficient. Efficiency is now an extremely fashionable term. Was greater efficiency a priority for you as a manager? What is the link between efficiency, effectiveness and productivity? How do you interpret efficiency as applied to cash management?**

**A.** Clearly a manager must always aim to raise productivity and operating efficiency. Whilst I was Head of the Treasury and Issue Department, I always sought to promote and execute proposals and projects that would

lead to real efficiency/productivity gains, such as functional restructuring at departmental level, human resources training/skills development and technological renewal of automatic sorting machines, to cite just a few examples.

However, I must say that in the cash management area and in a central banking context, I believe it is more important to focus on effectiveness (a job well done) than on efficiency/productivity (a job done quickly), as an error, no matter how small, may have repercussions on an institution's image and reputation, and we all know that these are precious assets for central banks.

**Q. What advice would you give in the fight against counterfeiting?**

**A.** The important growth in increasingly sophisticated technical resources, available through easily accessible channels such as the Internet and at low cost, has meant that anyone with basic technical skills can make reasonable copies of euro banknotes. Accordingly, the fight against counterfeiting must be approached from a variety of angles.

First, banknotes must be made increasingly secure, by using substrates with different characteristics from those easily available on the market and inks specially developed for use in euro banknotes, and by incorporating high-quality security features that are more resistant to counterfeiting. And second, there must be effective interaction between national central banks and the police.

Nevertheless, these two factors, namely the production of increasingly secure banknotes and top-quality investigation, are not sufficient alone. Professional cash users and the general public must be well-acquainted with their cash, so a third measure must be developed to fight counterfeiting, involving raising acquaintance with the euro.

To sum up, the fight against counterfeiting should be based on a combination of these three factors, to prevent counterfeiters from achieving their goals.

**Q. In Portugal the National Analysis Centre, which conducts technical checking of counterfeits, is run by the police, whilst the Treasury and Issue Department manages the counterfeit database and acts**

**as the contact with the European Central Bank and other national central banks. What are the advantages or disadvantages of this shared organization between the Banco de Portugal and the Portuguese police for counterfeit control?**

**A.** In truth, the organizational model in Portugal is a successful case study for other NCBs seeking to improve their understanding with the police. The model is based on laboratories that analyze counterfeit banknotes or coins, at both the Criminal Investigation Department and the Banco de Portugal (BP). All these laboratories use identical skills to ensure that counterfeits are correctly classified.

The National Counterfeit Centre, which always falls under the responsibility of the NCBs, manages both the BP National Analysis Centre and the BP National Coin Analysis Centre. However, this is by no means its only mission, as it is also responsible for managing the Counterfeit Monitoring System and the Euro Check Web Site, as well as for Training and Communication.

I see no disadvantages in this model but rather considerable advantages including, in particular, the synergies deriving from the joint participation of both institutions, in terms of the quality of the analysis obtained in the counterfeit classification process.

**Q. Based on your experience in cash management, what do you believe are the main future challenges facing central bank Treasury departments?**

**A.** I see a number of key challenges, at least for Treasury and Issue departments of central banks belonging to the Eurosystem: on the one hand, the difficulty in obtaining approval for the high investments associated with the technological renewal process (the need to adapt automated cash processing systems to multi-orientation and multi-face banknote feeding) and the need for skilled human resources in light of the growing reach of Treasury and Issue departments (regulation, monitoring and control of credit institutions and cash-in-transit companies in the context of the framework for detection of counterfeits and fitness sorting by credit institutions and other professional cash handlers); and on the other hand,

the growing demands and increasing pressure exerted by organizations representing credit institutions and cash-in-transit companies for adoption/implementation of concepts such as notes held to order and multi-denomination. All these points, in my view, still deserve more in-depth study.

One further challenge I foresee is a gradual loss of autonomy for Treasury and Issue departments in the Eurosystem decision-making process, and how the organizational structures will respond at a local level.

Lastly, a factor that will determine the impact of these challenges, and which may be considered the main challenge facing Treasury and Issue departments, is the adoption of a management model that defines their position in the cash cycle (centralization, sharing or delegation of responsibilities). This decision would not appear to be consensual and there is clearly no tailor-made solution.

**Q. Now turning to BILLETARIA, what is your opinion of the publication? What improvements would you suggest?**

**A.** I would like to congratulate the Banco de España on this excellent publication. It provides a forum for exchange of communication and information on common issues which I believe can be extremely useful for professional cash handlers worldwide.

I would like to make just two suggestions:

The first is that in order to be effective, the information presented should be concise and clear and, most importantly, it should be interesting; a long and unattractive publication runs the risk of remaining unread. The second suggestion is that it should be creative, or rather that it should reflect what we in the Treasury area do best. To conclude, I would add that these initiatives can make an important contribution, raising the visibility of the Treasury area and reinforcing its status and prestige, not only within central banks but also and especially with business partners. I would urge the Banco de España to continue to provide Treasury and Issue professionals and general readers with such a valuable initiative.



# The use of polymer in the banknotes of the Banco de México

■ Manuel Galán *Banco de México*

The Banco de México's interest in polymer dates back to 1996 when it first began to experiment with alternative substrates to paper for banknote production. Three different substrates were analyzed: DURANOTE, produced by Akro-Mobile, which is made up of two layers of polymer; LUMINUS, produced by Domtar, which consists of a thin layer of polymer covered on both sides with layers of cotton; and GUARDIAN, produced by Securrency, which is polymer created in such a way that the monomers are distributed in perpendicular fashion. All three substrates underwent laboratory tests and two underwent printing tests; as a result, the GUARDIAN substrate was chosen for further tests. In 2000 the Banco de México launched a research project on the viability of using alternative substrates, the main aim being to increase durability and, in particular, to enhance the quality of the lowest denomination banknote (the 20 peso note).

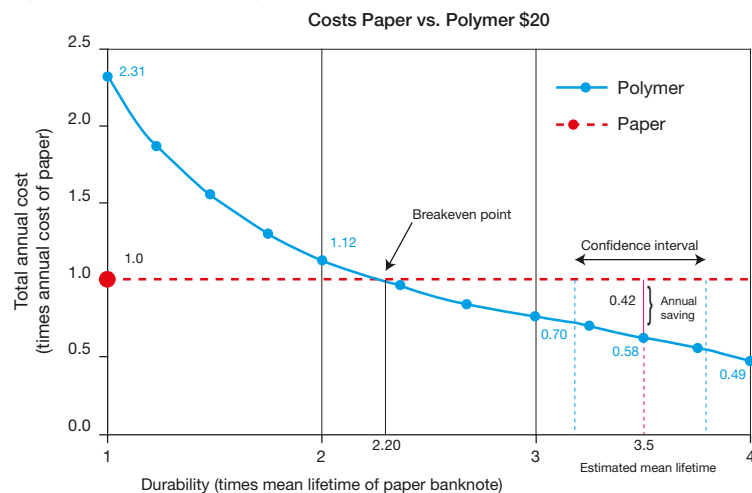
When the Banco de México decided to study the possibility of opting for polymer, a number of questions arose. Would polymer

banknotes last longer in Mexico than paper banknotes? Would they be safe from counterfeiting? Would the public accept them? What changes would the banknote production works have to make to use a polymer substrate? What problems would there be for processing polymer banknotes? Would ATMs work well with the new banknotes? What would the credit institutions think of them? What would be the costs and benefits for the Mexican people? This was to be an important change both for the general public and the financial system and for this reason the central bank designed a project divided into several successive stages: cost-benefit analysis; semi-industrial scale printing trial at the Banco de México's banknote production works; nationwide circulation trial; evaluation process based on focus groups; and nationwide survey of professional cash handlers, credit institutions and the general public. At the end of this process, the results were presented to the Governing Board for the final decision to be taken. This article presents a summary of the key findings at each stage of the project.

## Cost-benefit analysis

A cost-benefit analysis was conducted, considering the direct production costs, the estimated decline in productivity, the distribution cost and the coating cost. The analysis showed that if the lifetime of a polymer banknote was at least 2.2x the mean lifetime of the paper banknote it was to replace, then the project would be economically viable (see Figure 1).

Figure 1. Cost-benefit analysis



In the end, the estimated mean lifetime of the polymer banknotes proved to be 3.5x that of their paper counterparts. The calculations showed that the mean lifetime, with a confidence interval of 95%, was between 3.2x and 3.8x higher than that of the paper banknotes, implying an annual saving of 42%, assuming the same number of banknotes in circulation. The mean lifetime of the 20 peso note rose from 8.3 to 28.8 months.

## Semi-industrial scale trials and production viability

The printing tests conducted by the Banco de México with the GUARDIAN substrate produced important results in terms of the behaviour of polymer in the printing machines (see the article by Enrique Guarn-

er in this edition of BILLETARIA). As is well known, polymer banknotes require coatings. The coating process also had to be modified due to altitude, as Mexico City lies more than 2,000 metres above sea level and this meant that the polymer performed differently in the drying process. Technical problems of this kind arose throughout the printing tests, but they were all resolved with no adverse impact on the economic viability of the project.

The strategy followed by the Banco de México was to "polymerize" a denomination rather than replace it, that is, to respect, insofar as possible, the former design, so that the new banknote would form part of the existing series of banknotes, rather than replace it with a completely new design. Specifically, when the 20 peso note was polymerized, the same sheets or plates were seen to print differently, according to the substrate chosen, due to the different rate of absorption. Accordingly, changes had to be made in the thickness of the lines of the design of the banknote and in the spacing between the lines, so as to ensure that the polymer banknote was similar in appearance to the existing paper banknote.

In addition to the design modifications and the adjustment to the coating process, two further difficulties arose in the printing process. The first problem was blocking, as the printed sheets tended to stick together. The second problem was connected with physical handling of the polymer reams, as this proved to be quite different from handling paper reams. Nevertheless, all these problems were solved and the project progressed to the next stage.

## Circulation trial

The circulation trial began in September 2002 with the 20 peso note and had two key features: first it was a nationwide trial, which is important in a country such as Mexico in which there are not only huge differences in climate but also in the way in which people use their banknotes; and second the banknotes in circulation were replaced swiftly and completely. To this end the Banco de México created a large stock of 20 peso notes, enabling it to replace virtually all the notes in circulation (200 million) in the space of just eight months. This meant that all the population had immediate access to the new banknote; it also meant that the estimated mean lifetime figures were not distorted by the co-existence of the two different substrates.



50 Mexican peso polymer banknote.

## Surveys

The decision to change a banknote substrate cannot be taken lightly, as there are numerous technical, economic, cultural and even political aspects to be considered. To learn the extent of the cultural aspect of the decision, market research surveys were conducted among the general public and in the financial sector.

A year after the start of the circulation trial, a survey was conducted among 2,200 households, in towns and cities with more than 50,000 inhabitants. Interestingly, when asked "If you had the choice between a 20 peso coin, polymer banknote or paper banknote, which would you prefer?", 59% of the respondents said they would prefer a polymer banknote, 22% a paper banknote and 18% a coin. In addition, when asked "Would you like to see another denomination printed on polymer?", 68% said they would and only 31% said they would not.

Three months later another survey was conducted, in this case in the banking industry, among bank cashiers, banknote processing company staff and credit institution representatives. When asked "How would you assess polymer banknotes compared with paper banknotes?", the majority said they were cleaner (92%), better quality (64%) and more durable (94%). However, when asked "How do they compare in terms of processing?", the majority said that processing was more difficult (45%), slower (23%) or just the same (15%). Nevertheless, despite the greater difficulties experienced in processing polymer banknotes, the general opinion of the financial sector was positive and in favour of changing another denomination over to polymer.

## Processing polymer banknotes

Damage to paper banknotes results from their becoming soiled and flaccid, whilst damage to polymer notes results from ink loss or tearing. This difference in the way the banknotes become damaged presents a challenge in the initial stages of a first polymer note issue, as the central bank must establish a new standard for banknote fitness.

The Banco de México defined this standard by means of a range of ten banknotes showing progressive levels of deterioration, from a brand new banknote to one that was completely damaged. Initially, laboratory-produced photographs of damaged banknotes were delivered to the banks; after a couple of years, there were sufficient samples to be able to deliver them a complete set of damaged banknotes.

Two key changes were seen in the damaged banknotes that the banks returned to the Banco de México: there was a sharp drop in the number of damaged banknotes received, and an increase in the proportion of torn banknotes. Destruction outside the sorting machines was slower, but the number of banknotes to be destroyed fell considerably.

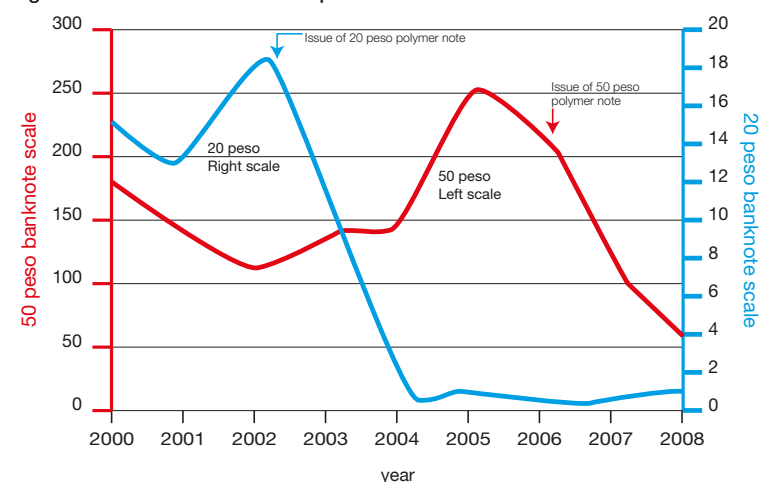
For the Banco de México, the new substrate implied no need for additional human resources in either banknote production or cash handling. Productivity levels did fall in some processes, but this was more than offset by the reduction in the number of banknotes produced or processed. An added advantage was that the greater durability of the polymer banknotes implied savings in the cash handling area, as the reduced flow of banknotes led to a decrease in commissions and in transport and insurance costs.

One change that was made was in the packaging system. The thermo-shrink plastic packaging was replaced, as it was suspected that when packets of new polymer banknotes were opened with knives, tiny cuts could be made on the edge of the notes that would subsequently become tears.

## Counterfeits

As indicated at the beginning, the main reason behind the introduction of polymer banknotes in Mexico was to extend the average lifetime and enhance the quality of the notes in circulation. However, and despite the fact that the number of counterfeit 20 peso notes detected each year was already quite low, in subsequent years there was a dramatic reduction in this number. In fact, as Figure 2 shows, in the six years since issue of the new polymer banknote, very few counterfeits using a plastic substrate have been detected.

Figure 2. Number of counterfeits per million banknotes in circulation



In November 2006 the 50 peso polymer note was issued. In that year, as in the previous two years, this was the most popular denomination for counterfeits in absolute terms. However, just one year later, the 50 peso note had dropped to third place in the counterfeit ranking, and in 2008 it fell to fourth place. Accordingly, in Mexico the introduction of polymer has been an important barrier to the type of counterfeits existing in the country.

## Conclusions

Adoption of a polymer substrate is a complex task that requires that many details be taken into account. Nevertheless, it has been a beneficial move, for the Banco de México and possibly for society overall. Polymer banknotes are cleaner, they are less costly to produce, they are less harmful to the environment and they are apparently safer from the threat of counterfeiting. The public information campaign conducted played an important role, informing the public about the new product and what to expect from it. A working group was also organized with the Mexican Banking Association to enable the Banco de México to learn and settle the concerns of the financial sector.

# Australia's experience with polymer banknotes

■ Robert Rankin *Reserve Bank of Australia*

The Reserve Bank of Australia issued the first polymer banknote more than two decades ago and completed the conversion of all denominations to polymer in 1996. This article examines the Reserve Bank's experiences with polymer banknotes, highlighting the impacts of polymer on security and the efficiency of distribution of Australia's banknotes.

## The impetus for polymer

The impetus behind the move towards a radically new type of banknote had its origins some 40 years ago when, in 1966, a new series of paper banknotes was introduced. This new series incorporated what were considered, at the time, to be state-of-the-art security features such as watermarks, embedded security threads, intaglio printing and coloured offset inks. Within one year, however, a number of high quality \$10 counterfeits were found in circulation. Although it was readily understood that the best an issuer can hope to achieve is to increase the cost and time that a counterfeiter allocates to producing a counterfeit banknote, the speed with which these counterfeits appeared was disturbing.

In response, the Reserve Bank established a 'think tank' comprising scientists from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national research organisation, and the Reserve Bank with the purpose of identifying innovative approaches to creating substantially more secure banknotes. Flowing from this, the CSIRO proposed developing a plastic-based substrate as a platform for the next generation of radically different security features. By the end of the 1980s, the production issues that had been identified during this research phase had been resolved to the point where the Reserve Bank was able to issue the first banknote printed on the new polymer substrate.

Australia's first polymer banknote – a commemorative \$10 banknote celebrating Australia's bicentenary – was issued in 1988. It effectively served as a trial for the new substrate and featured a clear window containing an Optically Variable Device (OVD). Feedback obtained from circulation trials was generally positive, with cleanliness and durability seen as major advantages. However, there were some concerns raised by members of the public and professional cash handlers about the feel and handling of the banknotes. Further research suggested that these issues could be overcome with changes

to production (for example, more texture from intaglio printing and improved overcoating) and to banknote handling practices. In view of these changes and because polymer banknotes handle and process through some machines differently to paper banknotes, extensive pre-release testing was co-ordinated with banknote accepting/dispensing machine manufacturers. Encouraged by the success of the trials, the decision was taken to produce Australia's next series of banknotes on a polymer substrate.

## A full polymer series

In July 1992, the Reserve Bank issued a \$5 polymer banknote, the first denomination of the new series. The final denomination in the new series, a \$100 polymer banknote, was issued in May 1996.

Despite the positive feedback to the commemorative banknote and the subsequent work undertaken to address the issues raised at the time, the initial response to the new banknotes was more negative than anticipated. Notwithstanding that much of the negative public comment was associated with the aesthetics of the new series design (and occurs whenever a new series is issued), objections were registered about the feel of the banknotes and a perception of handling difficulties. In regard to the latter, concerns were also expressed that the properties of the substrate made folding banknotes difficult and that this created storage problems.

The Reserve Bank worked closely with major cash handlers to identify and overcome these handling concerns. Specifically, 'user groups' with members of the cash handling industry were established to improve the dissemination of information on appropriate handling practices and to facilitate more comprehensive feedback on their experiences with the new banknotes. Minor adjustments in handling practices, such as the cessation of banknote folding, were integral to industry acceptance of polymer banknotes.

By the time that the last denominations in the series were issued in 1996, the industry had gravitated towards a preference for polymer. This preference for polymer is now entrenched. In a survey of suppliers of banknote validators in 1998, more than 80 per cent said that their machines were

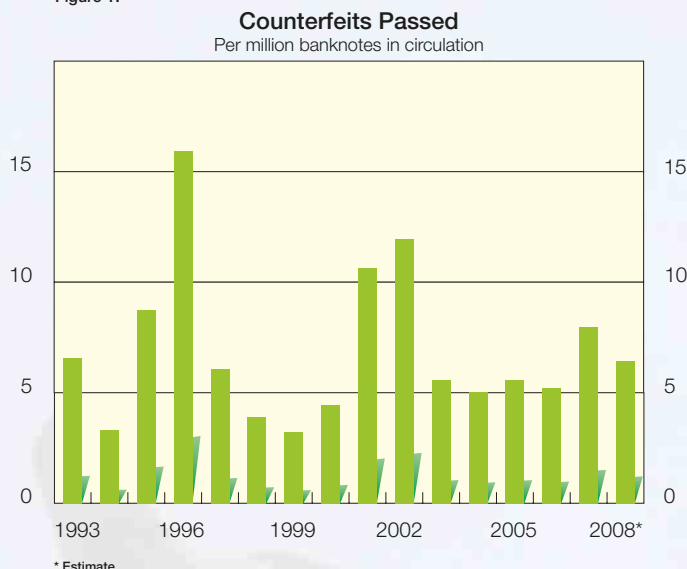
more efficient following Australia's move to polymer banknotes with less maintenance required and fewer errors. None of the suppliers that participated in the survey said their machines were less efficient.

## Security

The primary motivation for adopting a polymer substrate was to increase banknote security and thereby offer greater protection against counterfeiting. Initially it was expected that the additional security would be achieved by incorporating OVDs into the banknotes similar to the OVD used in the 1988 commemorative banknote. This feature proved to be less durable than originally expected, however, and was not included in the new polymer series. Instead, the Reserve Bank formed the view that the clear windows, combined with embossing, provided the significant improvement in the level of security that was required.

In the period since the Reserve Bank introduced the new polymer series, there has been a proliferation of affordable printing, scanning and graphics technologies that has seen counterfeit rates increase globally. Despite this global trend, the counterfeiting rate in Australia has tended to stay relatively low especially in comparison to rates experienced in other countries (Figure 1). Indeed, in the year to December 2008, about 6,400 counterfeits were detected with a nominal face value of around \$350,000. This represents around 6.5 counterfeits detected per million genuine banknotes in circulation. Importantly, almost all of the counterfeits detected in Australia are of poor quality, are printed on a paper substrate and are easily identified by feel as well as on visual inspection.

Figure 1.





One benefit of having very low counterfeiting rates relative to historical trends and relative to overseas experiences is that there has not been the same pressure as in other countries to upgrade the banknote series with enhanced security features or to introduce a new banknote series. Notwithstanding this, considerable research has been undertaken into a new generation of security features that take advantage of the unique properties of the polymer substrate.

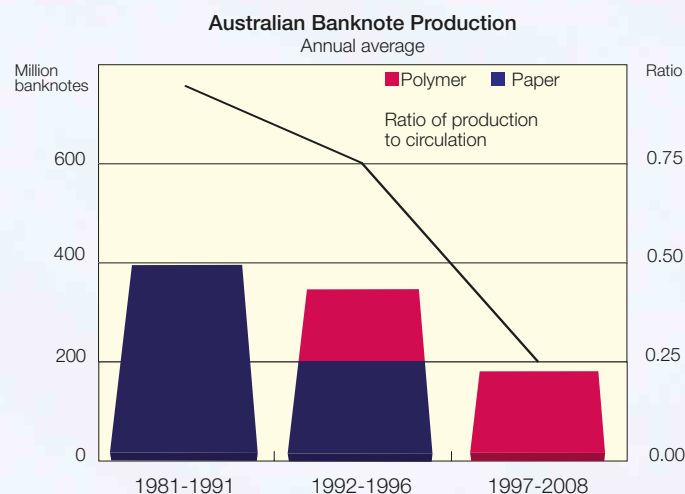
### Durability

The conversion to a polymer substrate has also provided a considerable benefit in terms of the durability of Australia's banknotes which, in turn, has realised considerable cost savings for the Australian public. Despite the number of banknotes in circulation doubling over the past twenty years, Australia currently produces less than half the number of banknotes than it did before the introduction of polymer banknotes (Figure 2). Considering that a significant proportion of production in the past few years has been associated with establishing larger contingency reserves, this implies that the average life of polymer banknotes is more than four times that of paper banknotes.

The increased durability of polymer banknotes is a consequence of a number of factors:

- the non-porous and non-fibrous nature of the substrate means that the banknotes do not absorb moisture;
- being non-fibrous, the substrate does not physically break down or go limp with repeated folding; and
- the toughness of the polymer substrate makes it more difficult to initiate a tear than on paper (although, once initiated, a tear can propagate very easily).

Figure 2.



### Processing machine adjustments

At the time that polymer banknotes were introduced in Australia, the Reserve Bank used Currency Verification Counting and Sorting systems to process banknotes that were repatriated from circulation. Some minor adjustments to the systems were required to deal with polymer banknotes. These included adjustments to the voltage of the strapper heat sealing mechanism to prevent damage to banknotes being strapped, more precise humidity control to assist with static management, a reduction in air supply to the banknote feeder to prevent lighter polymer banknotes lifting and manual air separation of the banknotes prior to feeding. These systems were successfully replaced with BPS 1000s in 2004, highlighting that polymer banknotes can be processed successfully on different manufacturers' platforms.

When polymer banknotes were introduced, there was an expectation that the primary means of determining the fitness of the banknotes would be through the detection of mechanical defects (ie. tears, holes, tape, missing pieces). The substrate proved to be so resilient, however, that it became clear that it was mainly the degree of inkwear that determined the fitness or otherwise of the banknotes and hence it was necessary to be able to detect different levels of inkwear as well as substrate defects. Consequently, the Reserve Bank commissioned an Australian company to develop an inkwear detector for the processing systems. When the Reserve Bank replaced its systems, the manufacturer of the BPS 1000, Giesecke & Devrient, successfully developed a new inkwear detector as well as a closed tear detector.

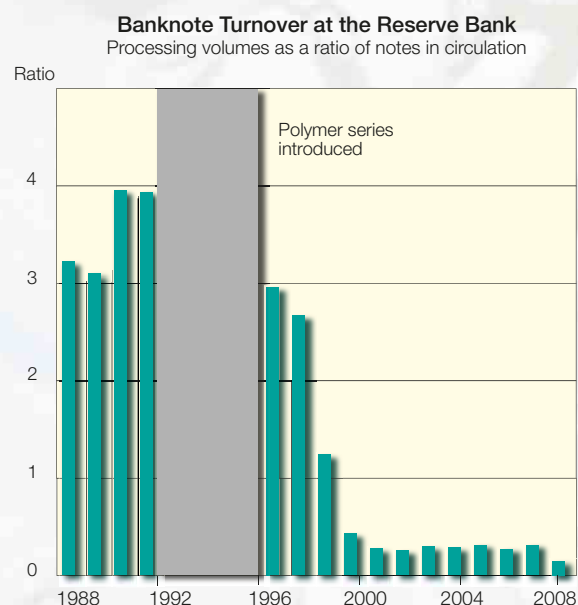
### Changes to distribution arrangements

The improved durability and security of Australia's banknotes have also been a catalyst for significant changes to the banknote distribution system.

With the introduction of polymer banknotes, examination of banknotes for fitness and authenticity by the Reserve Bank no longer needed to occur as frequently as it had for paper banknotes. In the absence of changes to the distribution system, however, the repatriation rates of banknotes to the Reserve Bank remained higher than was necessary, resulting in excessive processing of banknotes by the Reserve Bank (Figure 3).

The introduction of polymer banknotes provided an impetus to introduce significant efficiency improvements to the cash distribution arrangements in Australia. These included the privatisation of the banknote pools, the centralisation of the Reserve Bank's cash processing and distribution activities to the National Note Processing and Distribution Centre and the establishment of a Note Quality Reward Scheme that provides significant incentives to the industry to invest in fitness sorting infrastructure<sup>1</sup>.

Figure 3.



### Conclusion

The Reserve Bank's experience with polymer banknotes during the last two decades has been overwhelmingly positive, especially with regard to maintaining low levels of counterfeiting, a high quality of banknotes in circulation and a high level of efficiency in the banknote distribution system.

1. See the article by Michael Andersen from the Reserve Bank of Australia titled "The Note Quality Reward Scheme", published in Issue 3 of BILLETARIA in March 2008.

# Results of the circulation trial of a R\$10 polymer note commemorating the fifth centenary of the discovery of Brazil

■ João Sidney *Banco Central do Brasil*

In April 2000 the Banco Central do Brasil announced the issue of a 10 real commemorative banknote to be printed on polymer, with the aim of conducting a four-year circulation trial to assess the durability, resistance to counterfeiting and public acceptance of this new material in Brazil. During 2000 and 2001, the Casa da Moeda do Brasil printed 253 million pieces, on a substrate imported from the Australian plant that is the owner of the technology.

There are now some 9.1 million polymer notes in circulation; this is just 0.24% of all notes in circulation in Brazil (approximately 3.8 billion as of 10 March 2009) and 1.45% of the 10 real notes held by the public.

## Background

In 1999 the Board of the Banco Central do Brasil approved the circulation trial of a polymer banknote, motivated by the possibilities that the new material offered: greater durability (four times that of paper), greater difficulties for counterfeiters and greater resistance to soiling.

The 10 real (R\$10) note was chosen for the trial because it was the highest volume note in circulation and the note most used in ATMs and automatic processing machines. This meant that the trial would permit better assessment of the new material's security features by the public and better assessment of its performance in banknote processing equipment. Moreover, as it was an intermediate denomination, there would be less incentive for the public to keep the new notes as souvenirs, and thus more chance of success for the circulation trial.

The R\$10 polymer note was launched on 20 April 2000 to mark the 5th centenary of the discovery of Brazil. This was an ideal opportunity to test the new material and security features in a commemorative banknote, with no commitment to continue the issue as would have been the case in a normal note.

A total of 253 million R\$10 notes were issued; at that time, this represented approximately 50% of the total number of this denomination in circulation, thus permitting a more than adequate comparison with paper.

The following aspects were to be analyzed during the trial:

- how well the public adapted to handling polymer notes;
- the effective durability of polymer notes in handling conditions in Brazil;
- the resistance of the security features to counterfeiting attempts;
- how well the material behaved in cash processing machines at the central bank and commercial banks; and
- the ease or difficulty of printing on this new material at the Casa da Moeda do Brasil (CMB).

## Results

Below we present the results of the circulation trial, which concluded in the first semester of 2005:

- *Durability*: The trial showed that the lifetime of the polymer notes was 3.2 times that of the paper notes. However, there were signs that the durability analysis was affected by resistance on the part of banks to use the notes in ATMs and by resistance on the part of banks and retailers to handle the notes; this could significantly reduce the effective circulation and thus increase the durability figures.
- *Counterfeiting*: A small number of counterfeits was detected, most of very low quality. The coexistence of paper and polymer R\$10 notes could have "encouraged" paper counterfeits as this is a material that is very well known to counterfeiters.
- *Automatic processing and ATMs*: Minor adjustments alone were necessary in more modern equipment, but processing of polymer notes was impossible in older equipment. Processing productivity was 24% lower than in the case of paper notes; this problem was due to banknote deformation as a result of the handling practices and Treasury procedures in use in Brazil.
- *Economic analysis*: The circulation trial represented no additional cost for the central bank.
- *Public acceptance*: During the circulation trial, the central bank conducted three public opinion polls to assess acceptance of the polymer notes. The last such poll, conducted in 2004, showed that 56% of the public was in favour of polymer and 42% against. In the case of retailers and banks, 74% and 95%, respectively, preferred the paper notes.
- *Printing process*: For production of the polymer notes, adjustments had to be made to the printing equipment at the Casa da Moeda do Brasil. These adjustments were feasible, despite the significant drop



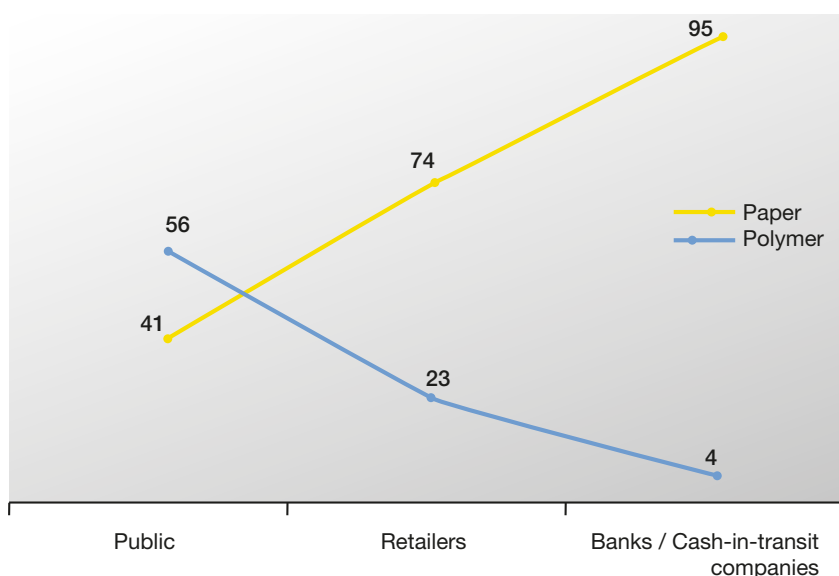
in productivity at several stages of the process. In the event of regular production of polymer banknotes, investment would be needed in varnishing equipment. Moreover, there is only one supplier of the polymer substrate worldwide, meaning that it must be imported from Australia.

Taking into account the abovementioned results, the Banco Central do Brasil considered that:

- adoption of the polymer substrate could involve a high adaptation cost, as it would require changes in handling practices by the public and in processing and storage procedures and Treasury operations at the central bank, banks and bulk cash handlers;
- for these changes to happen, and in order to benefit from all the characteristics of the polymer substrate, investment would be needed in training and education campaigns, as well as adjustments in the equipment and work procedures of the entire financial system;

- there was no clear indication that the public preferred notes printed on the polymer substrate to paper notes; and
- professional cash handlers strongly rejected the polymer notes.

**Preferences**



**Conclusion**

The central bank concluded that, at that time, there was insufficient evidence of the benefits of replacing paper banknotes with polymer notes, given the handling conditions and Treasury procedures in use in Brazil and the potential costs involved for the bank of issue, the financial system and society at large. However, the central bank reserves the right to re-examine the issue in the future, in light of the development of the use of polymer in other countries. The polymer notes are being gradually withdrawn from circulation as and when they become unfit.

# New Zealand's experience with polymer banknotes

■ Alan Boaden *Reserve Bank of New Zealand*

Between May 1999 and March 2000, the Reserve Bank of New Zealand replaced all circulating paper banknotes with polymer notes. The total number of notes in circulation then was 71 million pieces and there were five denominations. This article describes the Reserve Bank of New Zealand's experience with polymer banknotes, reporting on public acceptance, the durability of polymer banknotes, cost savings and the impact on the level of counterfeiting.

## Background

Traditionally central banks have maintained a pivotal role in the cash distribution cycle as it was considered that this was the safest way to ensure the integrity of notes in issue. In New Zealand, up until the year 2000, the Reserve Bank of New Zealand did just that, being the centre of the cash distribution cycle, with both fit and unfit notes being cycled from cash positive to cash negative banks via the Reserve Bank branch network.

In the late 1990s the priority of the Reserve Bank of New Zealand changed to one of getting better performance from the system with a longer term vision and open to innovation. The Reserve Bank took decisions that challenged the traditional way the Bank operated and required change and some risk-taking.

It was in this environment that the Reserve Bank of New Zealand decided to introduce polymer banknotes in 1999 and to use this change as a catalyst to downsize its involvement in the cash distribution cycle.

## Polymer banknotes

The key expectations for polymer banknotes were that they would:

- retain their structure and cleanliness;
- reduce the risk of counterfeits; and
- perform well in ATMs.

The Reserve Bank of New Zealand considered that if these objectives were achieved then public acceptance would be assured. It also expected they would result in cost savings over time.

In November 2000, after polymer notes had been in circulation for 18 months, an independent public survey found that 74% of the public and 90% of retailers preferred or strongly preferred polymer notes over paper. Since that time there has been no controversy over the quality of notes in circulation, apart from a few inevitable complaints that the lowest value note does not wear as well as the other denominations.

## Counterfeits

One of the prime motivations for the Reserve Bank of New Zealand's change to polymer notes was to take advantage of the security features offered by the new technology, especially the use of a transparent window. The New Zealand polymer notes have two clear windows, one of which has the numeral of the note embossed, as shown in the photograph. This feature is designed to be easily seen by the public and cash handlers without the need to hold the note to the light.

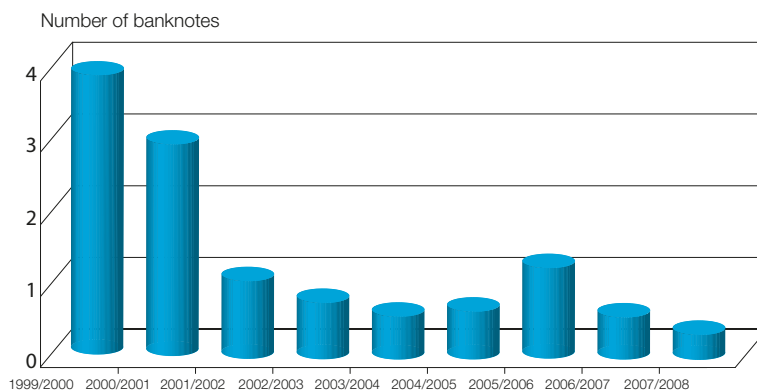


New Zealand \$50 polymer note with embossed window.

The polymer substrate itself has also proved to be a significant deterrent to counterfeiting, as it is difficult, particularly for amateurs, to produce a copy on plastic. To date, all counterfeit New Zealand notes detected have been produced on paper.

Since the introduction of polymer notes the number of counterfeits detected in New Zealand has fallen from low to very low levels by international standards. The introduction of polymer was followed by the closure of the Reserve Bank of New Zealand's branch offices and a large decline in the number of notes processed by the Reserve Bank. Given that for the last several years the Reserve Bank of New Zealand has only processed a fraction of the notes in circulation each year, the number of counterfeits the Reserve Bank of New Zealand detects per million notes processed is a more meaningful measure than the number found per million notes in circulation (as is often used in other countries). Figure 1 shows that over the last several years, with most notes in circulation being polymer, the number of counterfeits found has been low both by international standards and in comparison to earlier New Zealand experience.

Figure 1. Counterfeits detected per million notes processed<sup>1</sup>



1. The counterfeits detected in 2000 and 2001 were virtually all from the paper series.

## Performance

In New Zealand, as the polymer banknotes remained the same size as the existing paper notes, there were few problems in converting the ATM network to dispense the new notes in a very short period (about a month). The changeover only required a software adjustment, which was completed by branch staff in most commercial banks.

One of the main ATM servicing companies reported that after the introduction of polymer notes, there had been a decline of 50% in fault call-outs - from 5 to just 2.5 per ATM per month.

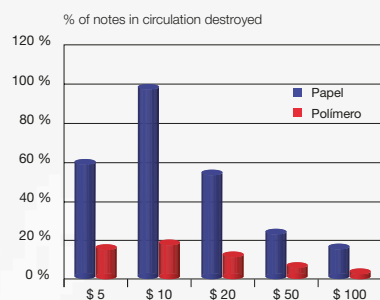
A relatively simple and inexpensive software upgrade enabled the Reserve Bank of New Zealand's own processing machines to identify paper notes for destruction and to band fit polymer notes ready for re-issue. The same machine-readable covert features that were incorporated in the paper notes were successfully implanted into the polymer design.

Initially there was some concern that the handling differences of polymer may cause difficulties for bank tellers, money handlers and the public. However, people adapted to the slight differences very quickly. The November 2000 opinion survey showed that 77% of the public and 80% of retailers gave positive ratings for ease of handling of the new notes.

## Cost effectiveness

- **Issue cost savings:** The longer effective life of the polymer substrate is the key to savings in new issue costs for the Reserve Bank. The experience in New Zealand has been that polymer banknotes retain their structure and cleanliness longer than paper notes. In 1997/98 the Reserve Bank of New Zealand's processing machines destroyed as unfit, 57% of all notes in circulation. In the past three years the Bank has destroyed just 12% per annum on average. A breakdown by denomination is illustrated in Figure 2.

Figure 2. Note destruction rates

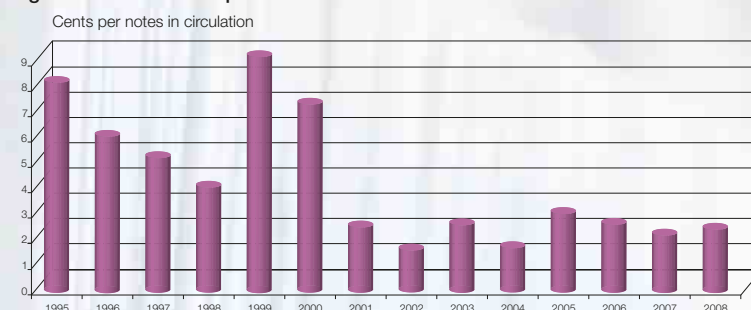


Initially polymer banknotes were generally removed from circulation due to physical damage such as holes, tears or defacement. However, the Bank now finds a similar number of notes that, through repeated handling, have suffered a degree of ink fade that warrants their withdrawal. It is normal when a country issues a new series of notes for them to have a "honeymoon period" when attrition rates are very low. But at some point numbers of worn notes rise to a rather higher level. New Zealand may be experiencing that transition now. Nevertheless, the average life of the three lowest denomination polymer notes is about 5 to 6 years, compared with 1.6 years when all notes were paper, ie about 3 to 4 times the earlier paper note life.

The greater durability of the polymer substrate translates into cost savings in the issue of notes to replace unfit. The annual cost of issue of banknotes (production, transportation, etc) divided by the average number of notes in circulation over the past thirteen years in New Zealand is illustrated in Figure 3.

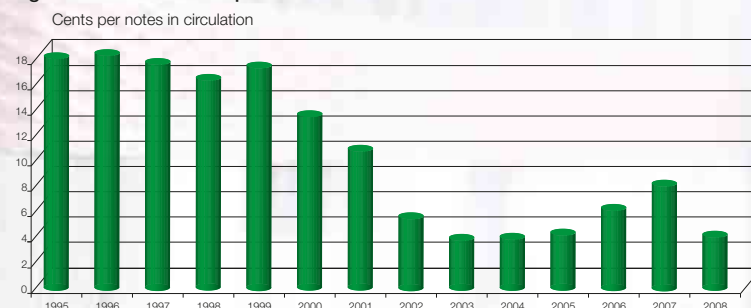
- **Downstream cost savings:** The cash operation of most central banks mainly revolves around ensuring the supply of fit notes and checking for quality and authenticity. The relatively short life of low value paper notes and in some countries concern over the level of counterfeiting drives central banks to significant involvement in the cash cycle. This is inherently an expensive business as it involves providing premises, security, processing machines and staff.

Figure 3. Note issue expenses<sup>2</sup>



The introduction of more durable and secure polymer banknotes in New Zealand enabled the Reserve Bank to become less involved in the daily cash distribution cycle. In 2000 the Bank closed its two branches and became predominantly a wholesale supplier. The reduction of the role of the Reserve Bank has resulted in very significant cost savings. Figure 4 shows the total cost of cash operations (excluding note and coin issue expenses) divided by the average number of notes in circulation.

Figure 4. Cost of cash operations<sup>3</sup>



## Summary and conclusions

In conclusion, the introduction of polymer banknotes has enabled the Reserve Bank of New Zealand to achieve several important objectives. The polymer notes have been well accepted by the general public, retailers and banks. They are more durable and this has generated considerable cost savings for the Reserve Bank and thus for New Zealand taxpayers. Their longer life has also facilitated a substantial reduction in the Reserve Bank of New Zealand's role in the cash cycle. The number of counterfeits found in New Zealand has declined significantly since the switch to polymer.

Counterfeits, destruction and costs	Paper banknotes (1995-1998)	Polymer banknotes (2006-2008)
Counterfeits detected per million banknotes processed	3.9	0.3
Destroyed banknotes in relation to the volume of banknotes in circulation (annual percentage)	60%	12.1%
Average issue cost (cents per banknote in circulation) (en céntimos neozelandeses)	5.3	1.8
Average cost of cash operations (cents per banknote in circulation)	16.4	4.4

2. Paper notes were issued 1995 to 1998. There was a transition period in 1999 and 2000 when all notes in circulation were replaced with polymer notes. From 2001 onward, only polymer notes were issued.
3. The rise in operating costs in 2007 was primarily due to some one-off expenses related to a review and change in coinage.

# Polymer banknotes in Romania

■ Razvan Dumitriu *National Bank of Romania*

Romania has now placed two series of polymer banknotes in circulation, so the article begins with a brief overview of the introduction of the plastic-based substrate in the country. It continues with figures from the National Bank of Romania on automatic banknote processing, to illustrate the greater durability of polymer banknotes. This is followed by a summary of the central bank's experience in connection with counterfeit polymer notes, to conclude with an overview of the advantages and disadvantages of the use of a polymer substrate.



## Issue of polymer banknotes

Polymer banknotes first came into circulation in Europe in 1999. In that year a 2,000 leu polymer note was issued in Romania commemorating the total solar eclipse that was clearly visible throughout the country on 11 August 1999.

Following the successful launch of this new banknote, the other denominations were gradually changed over from paper to polymer. The 10,000 leu paper banknote was the first to be replaced by polymer; the next polymer banknote to be issued was a new higher denomination (the 500,000 leu note). A year later the 50,000 and 100,000 leu notes were printed on a polymer substrate and the series was finally completed with issue of the 1,000,000 leu note.

In 2005, pursuant to Act 348/2004 for creation of a new monetary unit, the "new leu", in Romania, a new series of banknotes was placed in circulation. These new banknotes had a new face value: one new leu equalled 10,000 old lei. Similar designs to those of the previous series were used to prevent confusion among the general public. The original issue consisted of six denominations: 1, 5, 10, 50, 100 and 500

leu. In 2006 the 200 leu banknote was added to the series and, in 2008, the 10 leu banknote printed in offset was launched. The new banknotes include security features such as intaglio printing, translucent images, transparent windows with highlighted transient images, optically variable ink (OVI), iridescent stripes, latent images, microperforations and magnetic thread.

## Durability of polymer banknotes

The National Bank of Romania guarantees the authenticity, integrity and uniform quality of the banknotes in circulation. For this purpose, used banknotes are processed automatically and damaged banknotes are withdrawn. The central bank has nine automatic banknote processing machines, located in the four operational centres of the branch offices in Bucharest, Lasi, Cluj and Timis.

In 2007 the central bank processed 649 million banknotes, of which 26.7 million were deemed to be unfit. Accordingly, the percentage of banknotes deemed to be unfit for circulation was 4%, almost four times lower than in the euro area, as a result of the high quality and durability of the polymer substrate.

## Polymer banknotes and counterfeiting

Polymer offers much greater security against counterfeiting than paper. In 2007 a total of 1,801 counterfeit banknotes were detected in Romania; this was a decrease of 16% on the previous year and represented 2.23 counterfeit notes per million banknotes in circulation.

Most of the counterfeit banknotes detected were printed on a paper substrate and did not include the security features. The most copied banknote was the 50 leu note; approximately 60% of these copies were printed on a plastic substrate that aimed to imitate polymer. The second most copied banknote was the 100 leu note; approximately 25% of these copies were printed on plastic. The plastic material used by the counterfeiters was similar to the genuine polymer substrate, but the design quality and counterfeiting technique were quite poor, as there were significant differences in the physical properties of the materials used. Moreover, no attempt was made to copy the security features, with the sole exception of a highly rudimentary copy of the transparent window. Silkscreen printing was used for the white opacifier and digital printing for the remainder, probably using a high resolution inkjet printer.



Front of 500 leu banknote.

The plastic-based substrate used for the counterfeit notes was not the biaxially-oriented polypropylene that is used for the genuine banknotes. Instead the substrate used was ordinary polypropylene used for packaging, which has a different density and a rough surface in contrast to the smooth surface of biaxially-oriented polypropylene. Moreover, the genuine polymer substrate is thicker than the plastic material used in the counterfeit notes.

polymer banknotes do not absorb or retain moisture, oil, smells, bacteria or dirt;

- **easy machine-processing:** in most cases, polymer banknotes cause fewer processing problems than their paper counterparts in banknote processing machines and cash dispensing machines;
- **recycling potential:** polymer banknotes may be recycled at the end of their lifetime and used to produce a whole range of plastic products; this is a distinct advantage in terms of environmental sustainability.

### Conclusion

After almost a decade of experience in Romania, polymer banknotes have been seen to be considerably more durable and to offer considerably more security than paper banknotes. The non-fibrous nature of the polymer substrate means that it does not tear after repeated folding, as paper banknotes tend to do, and it makes polymer banknotes stronger and less likely to tear. With the shift to polymer, Romania joined the group of countries that have chosen to employ highly advanced technology in banknote production.

### Advantages and disadvantages of polymer as a banknote substrate

Key advantages of polymer over paper:

- **increased security against counterfeiting:** polymer is in itself a security feature;
- **longer average life of banknotes:** the durability of banknotes printed on a plastic-based substrate is at least three times greater than that of those printed on paper;
- **less absorption of dirt:** since the substrate is non-porous and bears a protective coating,

Key disadvantages of a polymer substrate:

- **the length of time polymer banknotes maintain alterations in their form,** for example, folds;
- **the strength of the plastic material,** which can easily damage some mechanical components of cash processing machines;
- **the difficulties involved in identifying by mechanical means** some of the security features of banknotes at the end of their lifetime.

# Polymer banknotes: the Chilean experience

■ Iván Montoya *Banco Central de Chile*

Within the context of a three-year evaluation programme, in September 2004 the Banco Central de Chile placed its first banknote printed on a polymer substrate in circulation. The public were informed that this was a new material that had been well received in other countries and that the central bank was keen to assess its acceptance and its behaviour in daily use in Chile.

## Polymer evaluation programme

"A window to the future" was the campaign slogan for the launch of the new banknote, making reference to one of the main characteristic features of polymer banknotes, namely the transparent windows. As this was an evaluation process, the original design of the denomination chosen for the exercise was maintained; in addition, this had to be a low denomination to ensure the least possible impact on the cash cycle in Chile in the event of it being necessary to return to the paper substrate.

The denomination chosen was the 2,000 Chilean peso note which at that time accounted for approximately 8% of all banknotes in circulation in the country. As the photographs show, the design features easily recognizable by the public were respected, whilst the information campaign accompanying the launch focused on the different characteristics of the new note, and especially of the polymer substrate.

Initial acceptance of the new banknote by the general public exceeded all the central bank's expectations, possibly due in part to the lack of innovation in the designs of the country's banknotes, which had been in circulation for some 15 years on average with no significant changes. The information campaign was less intense and less costly than expected for the Banco Central de Chile, owing to the media interest and coverage received.



2000 Chilean peso polymer (left) and paper (right) banknotes.



## Outcome of evaluation programme

The three-year evaluation programme was a vital source of information in the different areas of interest to the central bank, revealing all the strengths and weaknesses of the polymer notes for different sectors of the public and for professional cash handlers.

In the end the advantages outweighed the disadvantages and, as a result, the new series of Chilean banknotes currently being developed has three denominations printed on a polymer substrate and two on a cotton paper substrate.

In terms of a cost-benefit analysis, all the expectations were met. Among other advantages, the polymer banknotes were deemed to be cleaner and safer and this, together with a correct understanding of how to recognize authentic notes, makes it very easy to distinguish between an authentic note and a counterfeit.

During this time, the Banco Central de Chile has detected no counterfeit notes printed on any kind of plastic substrate. It is also important to note that most counterfeit banknotes in Chile are poor quality and are easily recognizable by duly informed users.

## Plans for the future

Some changes in habits are required for handling and processing polymer banknotes and these changes must be encouraged. Accordingly, when the new Chilean banknotes are launched, the information effort will intensify. The public are entitled to demand quality banknotes in good condition, but they are also responsible, as users, for helping to keep them in this condition.

Chile currently has very few banknote processing machines in the cash cycle; this is expected to change, to move towards the levels seen in more developed countries that serve as a benchmark for the Banco Central de Chile. When processing polymer banknotes, the limited number of machines available operate below par and below the levels seen elsewhere; the machine suppliers, the Chilean financial system and the cash-in-transit companies that process banknotes have all been duly informed.

Quality and efficient banknote processing is a matter of utmost importance in terms of strategic planning for the central bank, as it is directly linked to efficiency in the cash cycle and social wellbeing, measured in terms of the quality and integrity of the banknotes in circulation. In keeping with all the above, the Banco Central de Chile also intends to completely rebuild its banknote processing capacity.





# Polymer banknotes in Vietnam

■ **Nguyen Chi Thanh** *State Bank of Vietnam*

The State Bank of Vietnam was established in May 1951 and is responsible for meeting the demand for cash transactions among a population of 85 million people of whom approximately 30% live in urban areas. The State Bank is also responsible for deterring counterfeit activity and for maintaining the quality and the denomination structure of the currency in circulation. The national currency is the dong with 11 banknote denominations, ranging from 100 to 500,000 dongs.



## The decision to introduce polymer banknotes

Between 1997 and 2000 Vietnam experienced a significant increase in the number of high quality counterfeit notes. The paper notes in circulation were subject to continuous use and handling and there was significant deterioration as the notes quickly became limp and torn. In September 2000 a new 100,000 dong paper note was launched with enhanced security features such as OVI, a security thread and a high quality watermark. However, after a short period of time, high quality counterfeits of this note were detected and it became evident that Vietnam needed a comprehensive solution to improve both the security and the quality of the notes in circulation.

The State Bank considered a number of options before deciding on polymer banknote technology. The decision was based on several factors: polymer notes were a new banknote technology that had been proven in other countries; polymer notes had also been proven to be a high deterrent against counterfeiting, as they can incorporate similar security features to conventional paper notes together with unique polymer security features that are not only difficult to counterfeit but are also easily recognizable by the public. In addition, it was considered that polymer notes would be more durable and cleaner in circulation and that they would contribute to improvements in cash processing throughout the banking system, with significant potential cost savings for currency issuance.

## Long-term partnership agreement with Securrency

In 2002 the State Bank of Vietnam entered into a long-term partnership agreement with Securrency for the production of polymer notes; this included a comprehensive technical support program for both the State Bank and the National Banknote Printing Plant (NBPP) in Hanoi where the polymer notes for Vietnam were to be produced. Design of a new series of polymer notes was completed by the State Bank's designers and production of the first two denominations began in 2003. Polymer notes were produced on the existing note printing equipment at NBPP with the addition of overcoating facilities.

A number of difficulties arose in the early stages of production, but the State Bank and NBPP managed to learn all about the new banknote technology and successfully print polymer banknotes. NBPP was thus able to achieve production stability, produce high quality banknotes and secure reasonable spoilage rates (below 5%).

## Results

The 50,000 and 500,000 dong polymer banknotes were successfully placed in circulation in December 2003, followed by the 100,000 dong note in September 2004, the 20,000 dong note in April 2006 and the 10,000 and 200,000 dong notes in August 2006, thus completing the new series of polymer notes. The paper notes for these denominations were thus replaced and gradually withdrawn from circulation.

The key results of adoption of polymer note technology in Vietnam include fine tuning to achieve a more reasonable denomination structure, in keeping with the demand for cash in the economy. The new notes represent a significantly enhanced deterrent against counterfeits. The State Bank has responded to the public demand for securer, more durable and cleaner banknotes. In addition, NBPP has increased its technical expertise and production capacity.

Regarding counterfeiting, the combination of modern note designs, the new material and printing technology and the increased number of advanced security features has meant that the polymer notes are more secure. There has been an 80% drop in counterfeit notes per banknotes in circulation compared with the previous paper notes.

Analysis of samples of polymer notes collected from circulation by the State Bank shows that they maintain good durability, cleanliness and quality after four years in circulation. The medium to high denomination notes retain their quality and appearance for a significantly longer time, the security features maintain a high level of durability and functionality and there is little structural damage to these notes, which have an expected average lifetime of eight years. The lower denomination notes show good durability, cleanliness and quality, superior to that of the paper notes previously in circulation.

# Brazilian banknotes

■ Regis L. A. Rosa and Fabio Bollmann *Banco Central do Brasil*

The Currency Management Department (Departamento do Meio Circulante - MECIR) of the Banco Central do Brasil is responsible for currency issuance and banking services in Brazil. The central bank is headquartered in the capital, Brasilia, but the MECIR has its headquarters in Rio de Janeiro, with regional offices in Brasilia and in eight other state capitals.

In 1994, after a long period of high inflation with a series of economic plans and different monetary standards, the REAL Plan was finally launched; this economic plan was successful in stabilizing the economy and issuing the REAL, the country's new monetary unit.

In Brazil, currency production is entrusted by law to a public company, the Brazilian Printing Works & Mint (Casa da Moeda do Brasil - CMB), in Rio de Janeiro. Brazil is self-sufficient in almost all the materials used in the manufacturing process, including security paper, inks and coin blanks, with a large suppliers' network throughout the country.

The REAL banknote series consists of seven denominations - 1, 2, 5, 10, 20, 50 and 100 reais - although the lowest denomination (1 real) has not been produced since 2006. All the banknotes bear the same effigy of the Republic on the front, and different Brazilian fauna on the back. The creatures depicted, from the lowest to the highest denomination, are: the hummingbird (*Amazilia lactea*), the hawksbill turtle (*Eretmochelys imbricata*), the great egret (*Casmerodius albus*), the green-winged macaw (*Ara chloroptera*), the golden lion tamarin (*Leontopithecus rosalia*), the jaguar (*Panthera onca*) and the dusky grouper (*Epinephelus marginatus*).

At end-December 2008 there were 4,144 million banknotes in circulation, representing R\$112,722 million in value. The banknote in most use was the 50 real note, which accounted for 34% of all banknotes in circulation, as shown in the following figure:

Statistical data (31.12.2008)	Real	Euro
Total value of banknotes in circulation (million)	112,722	34,747.82
Average value of banknotes in circulation	27.20	8.38
Number of banknotes in circulation (million)	4,144	
Banknotes in circulation per capita	21.9	
Value of banknotes in circulation as a proportion of GDP	3.87%	

## Features of the 20 real banknote

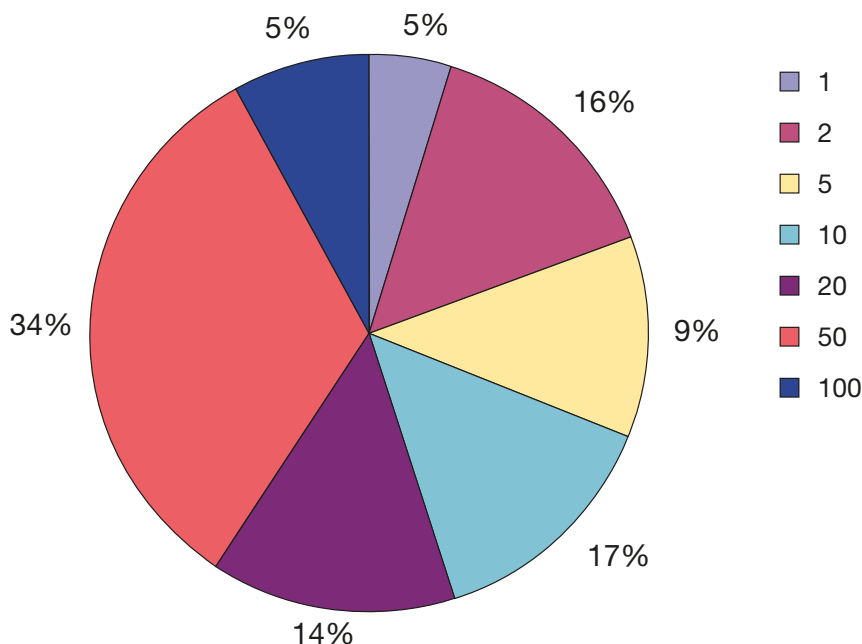
### Design and printing substrate

The 20 real banknote was issued in 2002 and was the last of the present series. It has a slightly different design from the others as it includes a holographic band on the front of the note.

The front of the banknote also bears the effigy of the Republic, portrayed as a sculpture. The reverse bears an image of the golden lion tamarin (*Leontopithecus rosalia*), depicted in reddish orange to golden brown, a primate native to Brazil's Atlantic forest, symbolizing the struggle for preservation of the country's endangered species. The 20 real banknote was issued to facilitate change in commercial transactions; the golden lion tamarin was chosen to reflect the wealth of Brazilian fauna. The theme of the banknote was chosen by means of a public consultation organized on the Internet and through surveys conducted in the country's main cities.

Similarly to the other six banknote denominations, the 20 real note is printed on cotton security paper. The paper differs in weight between the different denominations: 94 g/m<sup>2</sup> for the 2, 20, 50 and 100 real notes and 85 g/m<sup>2</sup> for the 1, 5 and 10 real notes.

Structure of banknotes in circulation



### Printing techniques

- **Intaglio.** This printing technique is used to apply tactile relief to the banknote. On the front it is used to print the effigy of the Republic, the words "Banco Central do Brasil" and the tactile mark; on the reverse, it is used to print the golden lion tamarin. It is also used on both sides to print the banknote face value.
- **Offset.** Used in the security backgrounds on both sides.
- **Typography.** Used in the numbering and seals on the front of the banknote.

### Security features for the general public

- **Watermark.** When the banknote is held up to the light, the number "20" and the golden lion tamarin can be seen, in hues that vary from light to dark, on both sides of the non-printed area.
- **Tactile mark.** Two oblique lines printed in high relief to enable the visually-impaired to recognize the banknotes.
- **See-through register.** When the banknote is held up to the light, the coats of arms printed on both sides of the note coincide to form a complete image.
- **Security thread.** A dark magnetic thread embedded in the paper, which becomes more visible when the banknote is held up to the light, with magnetic properties readable by banknote sorting machines.
- **Intaglio printing.** Tactile intaglio printing is used on both sides of the banknote, for the effigy of the Republic, the golden lion tamarin, the words "Banco Central do Brasil", "REAIS" and "VINTE REAIS" and the number "20".

- **Microprinting.** With the help of a magnifying glass, small "B" and "C" letters can be seen on the band next to the effigy of the Republic, in the number "20" and in the tree trunks at the bottom of the image of the golden lion tamarin on the back of the banknote.
- **Holographic band.** When the banknote is tilted, images of the golden lion tamarin and the number "20" appear as a hologram. With the help of a magnifying glass, the words "20 REAIS" can be seen at the bottom and, on the right-hand side, the words "Banco Central do Brasil".
- **Latent image.** When the banknote is held at eye level, horizontally and in good light, the letters "B" and "C" become visible in the orange rectangle.
- **Security background.** Very thin straight and sinuous coloured lines that run across the entire banknote.

### Technical features

Substrate	Paper 100% cotton fibre
Substrate weight	94 g/m <sup>2</sup>
Dimensions	140 mm x 65 mm
Dominant colours	Yellow and orange



# Currency Management Directorate of the Banco Central de Reserva del Perú

■ **Juan Antonio Ramírez** *Banco Central de Reserva del Perú*

The Currency Management Directorate reports to the Central Operations Directorate, which in turn reports to the General Directorate of the Banco Central de Reserva del Perú. The purpose of the Currency Management Directorate is to:

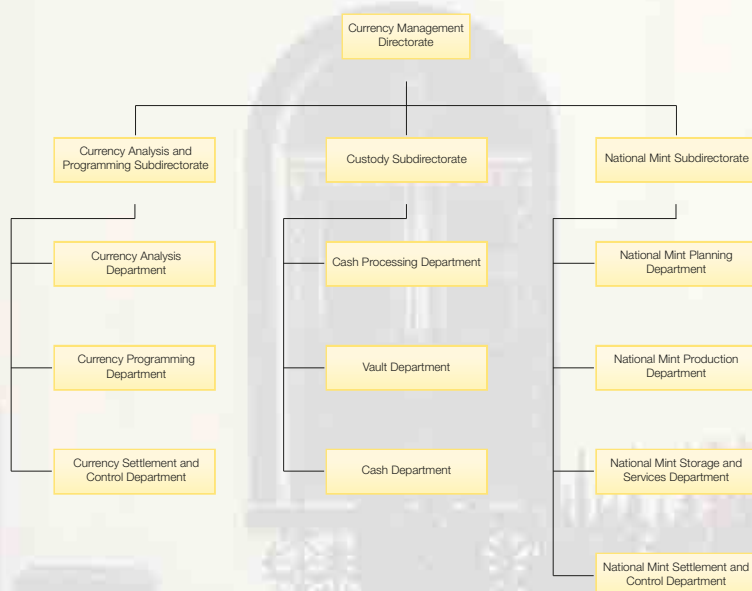
- provide the economy with an appropriate supply of banknotes and coins, to facilitate smooth transactions, considering both the volume of banknotes and coins required and the breakdown between the different denominations;
- prevent difficulties in obtaining coins;
- reduce transport costs for economic agents and minimize currency handling costs.

The Banco Central de Reserva del Perú has its headquarters in Lima. It also has seven branch offices, strategically located across the country to guarantee the correct supply of banknotes and coins.

## Organizational structure

The Currency Management Directorate is divided into three separate units: Currency Analysis and Programming, Custody and the National Mint.

The **Currency Analysis and Programming Subdirectorate** conducts studies and implements the necessary policies to guarantee the correct supply of cash. It also proposes the design characteristics and security features of the banknotes and coins. The Subdirectorate is divided, in turn, into three departments: Currency Analysis, Currency Programming and Currency Settlement and Control.



The Currency Programming Department determines cash supply requirements and programmes the circulation of cash.

The Currency Analysis Department is responsible for all activities connected with design and communication of security features, procurement of banknotes via international tender bids (tender by invitation only) and preventive measures to fight counterfeiting. It also defines and proposes commemorative issue programmes.

The Currency Settlement and Control Department keeps an appropriate and timely record of the daily cash transactions of the Custody Subdirectorate.

The **Custody Subdirectorate** is responsible for custody and administration of cash, to guarantee that banknotes and coins are in sufficient supply, in accordance with the established schedule and the needs of the financial system. These activities are conducted through three separate Departments: Cash, Cash Processing and Vault.

The Cash Department focuses on exchange of cash with, delivery of cash to and withdrawal of cash from the financial institutions and the general public. This Department is also responsible for supervising qualification and validating withholding of counterfeit or unfit banknotes and coins.

The Cash Processing Department sorts the cash received from the financial institutions between that which is fit for circulation and that which is unfit.

The Vault Department receives, stores, holds in safekeeping and dispatches gold, silver, banknotes, coins and other valuables. It also processes orders for cash from the central bank's branch offices and the financial system.

**National Mint Subdirectorate.** Peru was one of the first countries to establish a National Mint, back in the second half of the 16<sup>th</sup> century<sup>1</sup>; the Mint now has an ISO 9001-2000 quality certificate. The Mint's main role is to manufacture coins in accordance with the production programme approved each year by the Board of the Banco Central de Reserva del Perú. In addition, it produces numismatic coins, tokens and medals and undertakes artistic work for third parties. The Subdirectorate, which is also responsible for preparing and supervising execution of the Mint's budgetary programme, includes three separate organizational departments.

The Planning Department aims to assure the efficiency of the production system and the quality of the finished product. For this purpose, a comprehensive production programme is drawn up for coins, tokens and tooling, in addition to maintenance, quality and production control programmes.

The Production Department mints coins and manufactures tokens in accordance with the terms of the comprehensive production programme, suggesting and evaluating possible process improvements to raise productivity and enhance product quality.

The Storage and Services Department manages supply and storage services.

1. On 21 August 1565, Philip II signed the Royal Warrant creating the Lima Mint. The first coins (macuquinas) were made of silver and were minted manually, by anvil and hammer.

Lastly, the Settlement and Control Department keeps an appropriate and timely record of the activities of the National Mint and prepares its budget, among other functions.

### Management tools

Cash management involves a number of tools including, in particular, the custody service, the quality standard and the predetermined denomination system for the financial institutions.

#### ■ Custody service

This is one of the most important management tools of the Banco Central de Reserva del Perú. Not all banknotes are held at the central bank; some are held in the vaults of banks and other duly authorized financial institutions. All cash movements are debited or credited as appropriate by these banks or other institutions in current accounts held with the central bank. This prevents the need for physical transport of banknotes from depositories and financial institutions, leading to enhanced management of banknote stocks, easing of congestion in central bank operations and lower cash transport costs.

The custody service is administered by the Banco Central de Reserva del Perú, which requires that the financial institutions concerned have the necessary insurance. The service has been authorized in areas in which the central bank had no branch offices.

#### ■ Quality standard

The purpose of this management tool is to ensure that the banknotes in circulation are fit for purpose, to ensure that transactions may be made swiftly and safely.

The Banco Central de Reserva del Perú sorts the banknotes in circulation into different quality levels, on the basis of their feel. Periodic visits are made to the financial institutions, to the counters that serve the general public and to the custody service vaults, to check that the quality standard is being met.

#### ■ Predetermined denominations for the financial system

In response to requests for banknotes from the financial system, the Banco Central de Reserva del Perú delivers the total volume in accordance with a predetermined denomination structure, the aim being to ensure that all banknote denominations circulate throughout the country and to prevent the general public from being deprived of certain denominations as a consequence of any operational preferences on the part of the financial institutions.

### Fight against counterfeit banknotes and coins

This area of activity, which is of key importance for the Banco Central de Reserva del Perú, **has four strategic fronts**: choice of appropriate security features; communication of these features to the general public; intelligence work; and penalties.

#### ■ Security features

In this respect, the central bank's aim is twofold: to make it easier for banknotes and coins to be identified and to make it more difficult for them to be counterfeited. In the case of banknotes, the Banco Central de Reserva del Perú has constant meetings with printing works and security paper and ink manufacturers to obtain information on the latest technological advances in banknote security features. As a result of these conversations, since the *nuevo sol* was placed in circulation a number of security features, such as optically variable ink, electrotype watermarks,



iridescent stripes and holographic threads for the higher denominations, have gradually been incorporated into the banknotes. In the case of coins, certain details have been fine-tuned.

#### ■ Communication

This is one of the most well developed areas, as the Banco Central de Reserva del Perú has a broad communication infrastructure, reflected in talks given to the financial system, and to retailers, students and the general public, distribution of posters and leaflets on banknote security features and interviews with the mass media.

As an indication of the broad scope of this area of activity, in the period 2000-08 the Banco Central de Reserva del Perú gave approximately 6,000 talks to a total of 225,000 persons and distributed some 2 million posters throughout the country.

#### ■ Intelligence work

In connection with the aim to effectively strike out counterfeits, the Banco Central de Reserva del Perú established the Central Office for the Fight Against Counterfeits. This Office is headed by a Board of five Directors, three of whom are appointed by the Board of the Banco Central de Reserva del Perú and two by the Justice and Interior Ministries, respectively.

The Office conducts intelligence work, aimed at dismantling organized counterfeiting groups. It also arranges seminars for the police force, the Attorney General's office and the judiciary, to highlight the severity of monetary offences and the importance of punishing those responsible, and to endeavour to unify the criteria of the groups involved in the fight against counterfeiting.

#### ■ Penalties

At the initiative of the Banco Central de Reserva del Perú, legislation was passed raising the minimum penalty for counterfeiting offences or for distributing counterfeits from four to five years. This implies effective imprisonment for counterfeiters.

Statistical data <sup>1</sup>	2006	2007	2008
<b>Banknotes in circulation</b>			
- Value	13,651.0	16,999.4	20,457.9
- Volume	245.8	301.5	345.3
<b>Banknotes sent out by central bank<sup>2</sup></b>			
- Value	41,913.0	39,540.7	48,602.9
- Volume	905.8	922.6	1,122.7
<b>Banknotes deposited with central bank</b>			
- Value	37,259.9	34,058.7	40,145.6
- Volume	806.1	808.3	947.0
<b>Banknotes processed by central bank</b>			
- Value	4,942.9	4,816.8	5,242.8
- Volume	147.5	143.2	162.9

1. Value expressed in thousand million *nuevos soles* and volume in million banknotes, at each year-end.

2. Includes Custody service.

# Commemorative euro coins

■ María José Fernández Lupiáñez and J. Darío Negueruela *Banco de España*

The citizens of the European countries that form part of the euro area use the same euro banknotes and coins in their respective countries. The family of coins is made up of eight denominations following the 1-2-5 sequence, running from the 1 cent to the €2 coin, grouped into three levels (low, medium and high), each with different designs and composition. Unlike the banknotes, the euro coins differ in design between the different countries, as each coin has one common side that is identical for all the euro countries and one national side that is distinct to each different country; moreover, these designs may vary between the three different groups of coins (low, medium and high). Another important difference is that whilst all euro banknotes are issued by the European Central Bank and the national central banks that are members of the Eurosystem, euro coins are issued by the Treasury of each Member State. There are, therefore, a great variety of euro coins: 128 in total (eight denominations each for all 16 euro area countries), plus another 24 resulting from the special agreements signed with the Vatican, Monaco and San Marino, making a total of 19 euro coin issuer States.

## Types of euro coins

There are two types of euro coins: those issued for circulation, which may be subdivided between “normal” and commemorative coins, and those not issued for circulation or collector coins.

“Normal” coins are those used as the regular means of payment in the euro area and which are admitted for this purpose throughout the euro area, irrespective of their country of issue. These coins serve as the currency of payment and discharge for settlement of debts, although only in a limited number (in general up to a maximum of fifty coins<sup>1</sup>). All euro coins have the same image on the reverse (the common side), but the image on the front (the national side) differs according to the country of issue. All 10 cent coins and higher denominations have a map of Europe on the common side; in 2005 it was decided to redraw this map to include all the countries of Europe. Picture 1 shows the map prior to enlargement of the European Union on 1 May 2004; Picture 2 shows the new common side that came into circulation as from 1 January 2007 (obligatory in all countries as from 2008) and that includes all the countries of Europe with no national boundaries. Both designs are permanently valid.

This variety of national sides (152 in total) and designs is a plus point for Europeans, but it requires regulations to prevent any uncertainties regarding the legitimacy of the coins. For this reason:

- all euro coins intended for circulation issued as from 2005 identify the State issuing the coins, to ensure that there are no doubts regarding their origin;
- neither the name nor the denomination on the reverse side may be repeated in the same form on the front of the coins, unless this is due to the use of a different alphabet<sup>2</sup>;



Picture 1



Picture 2

- the designs on the national side of the coins may not be changed, save in the event of a change in the Head of State portrayed on the coins, although the effigy of the Head of State may be updated every fifteen years to adapt to the passing of time.

Other design characteristics:

- the words on the edge of the 2 euro coin may refer to the denomination, provided they use only the figure «2» and/or the word «euro»;
- the national side of all euro coins intended for circulation must bear the 12 European stars and these must completely encircle the national design, including the year of issue and the name of the issuing State;
- the European stars must appear in the same form as that in which they appear on the European flag.

**Commemorative coins** are €2 coins issued by the Member States to commemorate an anniversary or an important event. These coins are valid for circulation and as the currency of payment and discharge for settlement of debts.

Commemorative euro coins must have the same common side as ordinary euro coins; the difference is on the national side, which depicts the figure honoured or event commemorated.

Commemorative issues were traditional among the Member States prior to the introduction of the euro. Accordingly, in 2004 the Member States were authorized to make commemorative issues, subject to the limits and authorizations indicated below. The €2 coin was considered to be the most appropriate coin for this purpose, owing to its size (which makes it easier to adapt a design) and its technical characteristics (which make it more difficult for counterfeiters to copy). In addition it was considered that the coin's higher value would make it easier for the issuing States to meet their production costs and ensure a certain level of revenue, as many of these commemorative coins will be collected by the public.

**Collector coins** are coins that are not intended for circulation and they must be different in terms of denomination, size and design from euro coins intended for circulation. They are made of precious metals (gold or silver) using optimum minting techniques (Proof) and are issued in very limited numbers. These coins are legal tender only in the country in which they are issued, in accordance with the rules established in each specific case. They are sold to the public at more than face value as they are highly valued by collectors.

1. Article 11 of Council Regulation (EC) No 974/98 of 3 May 1998 on the introduction of the euro.

2. European Commission Recommendation of 19 December 2008 on common guidelines for the national sides and the issuance of euro coins intended for circulation.

### Issue and circulation of commemorative euro coins

In general, each euro area country may issue only one commemorative coin per year. There are, however, two exceptions to this rule: joint commemorative issues to mark an important event, for example, in the history of Europe; and issues made in the event of the disappearance of a Head of State, leaving the post temporarily vacant or in the hands of a provisional replacement.

total number of €2 coins in circulation, to prevent the “normal” euro coins from being replaced by commemorative coins, whilst at the same time permitting issuance of a sufficient number of coins so as to permit real circulation of the commemorative coins and to prevent them from disappearing into the hands of collectors.

Descriptions of the commemorative designs and any other relevant details will be published in the Official Journal of the European Union.

Figure 1. Euro coin characteristics

Characteristics	Coins intended for circulation		Coins not intended for circulation
	“Normal” coins	Commemorative coins	Collector coins
Legal tender	Yes, throughout euro area.	Yes, throughout euro area.	Yes, but only in country of issue.
Face value	€2 - €1 50 cent - 20 cent - 10 cent 5 cent - 2 cent - 1 cent	€2	€10 - €12 - €20 - €50 - €100 - €200 - €300 - €400 etc.
Annual issue	Issued regularly in accordance with economic needs.	Once a year in each individual State (save in the case of joint issues), in a fixed amount.	Date and amount at discretion of issuing State.
Material	Must comply with European Commission conditions on form, alloys, composition and quality controls.	Identical to “normal” coins.	Precious metals, at discretion of issuing State.
Minting	Normal.	Normal.	Proof.
Placed in circulation	At face value.	At face value.	Retail price set in regulations governing issue.
Front	National side, approved by European Commission.	National side changed to depict figure honoured or event commemorated.	Free design.
Reverse	Common side.	Common side.	Free design.
Issued as from	2002	2004	2002
Obligation to inform	Maximum amount to ECB and European Commission.	European Commission, six months in advance.	None.



Picture 3



The first commemorative euro coin issued in Spain, dedicated to the figure of El Quijote

Member States wishing to issue a commemorative coin must notify the European Commission at least six months in advance. The total number of commemorative coins placed in circulation by a single State in any one year may not exceed the following limits<sup>3</sup>:

- 0.1% of the total number of €2 coins placed in circulation by all the participating Member States up to the start of the previous year. By way of exception this limit may be raised to 2%, according to the importance of the event commemorated, but in this case the Member State making the issue will then abstain from making any further commemorative issues during the next four years.
- 5.0% of the total number of commemorative €2 coins placed in circulation by the Member State up to the start of the previous year.

These maximum limits on the volume of commemorative issues aim to ensure that these coins represent no more than a small percentage of the

### Commemorative euro coins issued

As of February 2009, fourteen countries had made commemorative issues (not including the joint issues described below), implying placement in circulation of 40 different varieties of the bimetallic €2 coin: six in 2004, eight in 2005, seven in 2006, seven in 2007, ten in 2008 and two to date in 2009. The occasions marked are also very varied: historic or cultural events, commemorations of agreements or of the creation of international organizations, monuments, etc. (Figure 2).

To date a total of 326.62 million commemorative euro coins have been issued (the volume differs in each issue, ranging from 100,000 coins to up to 50 million coins).

The first commemorative €2 coin was issued by Greece in 2004 to commemorate the Athens Olympics (see Picture 3). The coin bears the image of the Discobolus (a classical Greek sculpture attributed to Myron), the logo of the 2004 Athens Olympics and the five Olympic rings, as well as the coin denomination in Greek (2 ΕΥΡΩ).

3. Article 6 of the European Commission Recommendation of 19 December 2008 on common guidelines for the national sides and the issuance of euro coins intended for circulation.

# Banknotes and coins

## Commemorative euro coins

For its part, Germany has launched a series of coins dedicated to the Federal Republic's 16 Federal States (*Die 16 Bundesländer der Bundesrepublik Deutschland*). The first commemorative coin was issued in 2006; the remaining fifteen are to be issued, at the rate of one each year, through 2021 when the Federal State commemorated will coincide with that presiding over the *Bundesrat*.

To date the euro area countries have made two joint commemorative issues: the first, in March 2007, when thirteen countries issued coins commemorating the 50th anniversary of the signing of the Treaty of Rome (picture 4); and more recently, in January 2009, when sixteen countries issued coins commemorating the 10th anniversary of Economic and Monetary Union (EMU) (picture 5). As the pictures show, Spain took part in both issues.

A total of 87,453 million coins were issued commemorating the anniversary of the Treaty of Rome, and a marginally smaller number, 83,885 million, commemorating the 10th anniversary of EMU.

Adding these joint issues to those described above, a complete collection of commemorative euro coins issued up to February 2009 would comprise a total of 69 bimetallic coins.



Picture 4



Picture 5

Figure 2. Commemorative euro coins issued up to February 2009 (not including joint issues)

	2004	2005	2006	2007	2008	2009 (feb.)	
<b>Austria</b>		50 <sup>th</sup> anniversary of Austrian State Treaty					<b>1</b>
<b>Belgium</b>		Belgium-Luxembourg Economic Union	Atomium		60 <sup>th</sup> anniversary of Declaration of Human Rights		<b>3</b>
<b>Finland</b>	European Union enlargement	60 <sup>th</sup> anniversary of founding of United Nations	1 <sup>st</sup> centenary of universal and equal suffrage	90 <sup>th</sup> anniversary of Finnish independence	60 <sup>th</sup> anniversary of Universal Declaration of Human Rights		<b>3</b>
<b>France</b>					French presidency of Council of European Union in second half of 2008		<b>1</b>
<b>Germany</b>			Schleswig-Holstein	Mecklenburg-Vorpommern	Hamburg	Saarland	<b>4</b>
<b>Greece</b>	Athens Olympics						<b>1</b>
<b>Italy</b>	50 <sup>th</sup> anniversary of World Food Program	1 <sup>st</sup> anniversary of European Constitution	20 <sup>th</sup> Winter Olympics, Turin 2006		60 <sup>th</sup> anniversary of Declaration of Human Rights		<b>4</b>
<b>Luxembourg</b>	Effigy and monogram of Grand Duke Henri	50 <sup>th</sup> birthday of Grand Duke Henri and centenary of death of Grand Duke Adolphe	25 <sup>th</sup> birthday of heir to throne, Grand Duke Guillaume	Grand Ducal Palace	Grand Duke Henri and Château de Berg	Grand Duke Henri and Grand Duchess Charlotte	<b>6</b>
<b>Portugal</b>				Portuguese presidency of European Union	60 <sup>th</sup> anniversary of Universal Declaration of Human Rights		<b>2</b>
<b>Slovenia</b>					500 <sup>th</sup> anniversary of birth of Primož Trubar		<b>1</b>
<b>Spain</b>		4 <sup>th</sup> centenary of first edition of <i>El Quijote</i>					<b>1</b>
<b>Monaco</b>				25 <sup>th</sup> anniversary of death of Princess Grace			<b>1</b>
<b>San Marino</b>	Bartolomeo Borghesi	World Year of Physics 2005	5 <sup>th</sup> centenary of death of Columbus	Bicentenary of birth of Garibaldi	European Year of Intercultural Dialogue		<b>5</b>
<b>Vatican City</b>	75 <sup>th</sup> anniversary of founding of Vatican City State	World Youth Day 2005	5 <sup>th</sup> centenary of Swiss Guard	80 <sup>th</sup> birthday of His Holiness Pope Benedict XVI	Year dedicated to Saint Paul the Apostle on the 2000 <sup>th</sup> anniversary of his birth		<b>5</b>
<b>Total</b>	<b>6</b>	<b>8</b>	<b>7</b>	<b>7</b>	<b>10</b>	<b>2</b>	<b>40</b>



# Guardian® technology starts with the film

■ Bruno Garoffolo and Paul Sientek *Securrency International Pty Ltd.*

Polypropylene forms the base material of the polymer-based banknote. It is a by-product of petroleum, which forms the building block for a range of products such as adhesives, plastics, cosmetics, etc.

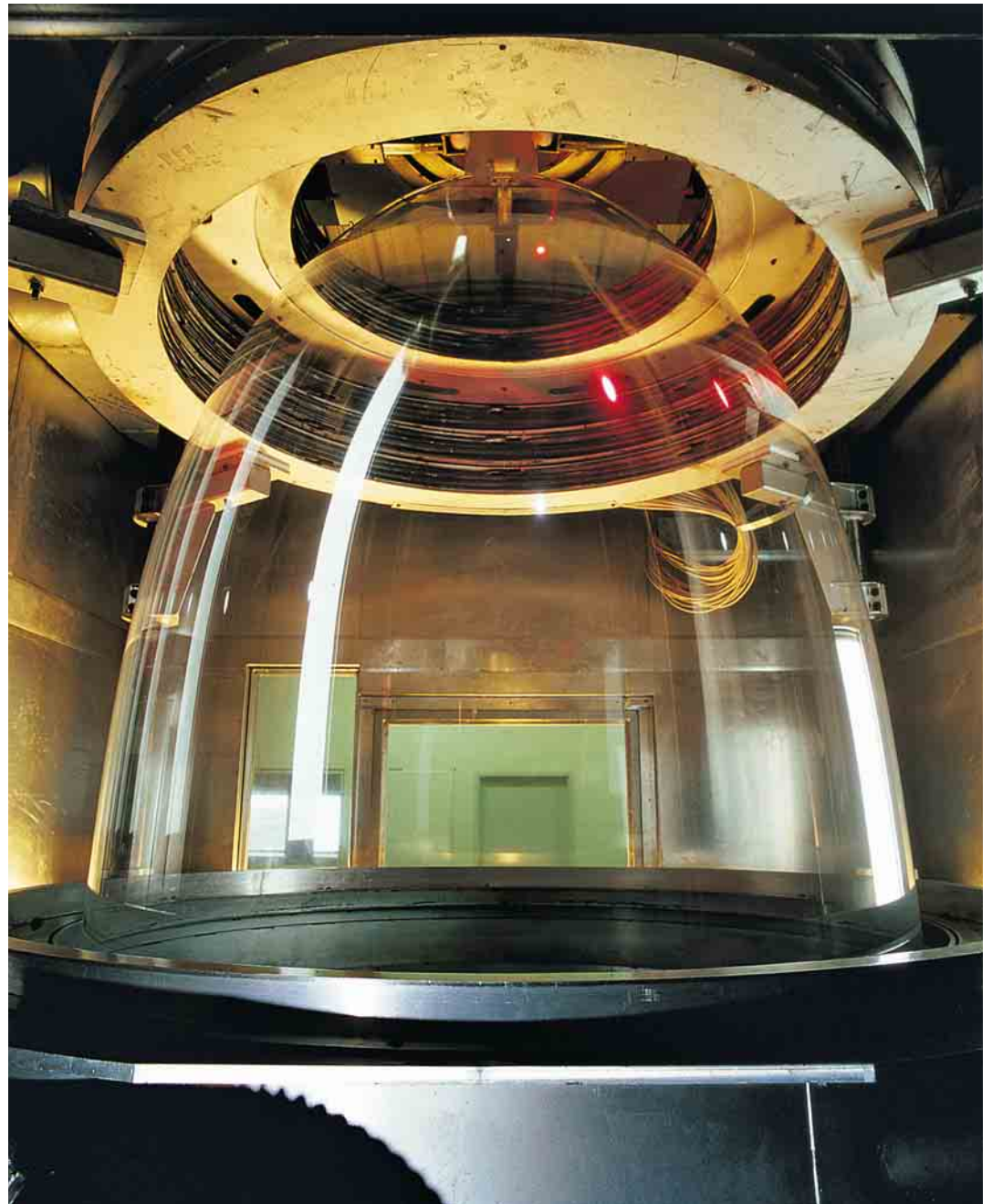
The polypropylene is then further processed and pelletized to produce the raw materials for the polypropylene films. These specially formulated polypropylene pellets are then converted into film using the unique “bubble process”.

The polypropylene pellets are extruded and the molten polymer is snap cooled on a brass mandrill. The rapid cooling process provides many of the properties of the film – especially its transparency. The cast tube is then reheated and, with a combination of temperature and air pressure, the tube is blown outward – creating a large “bubble”. The bubble is then collapsed, slit and wound into reels, as the base for Guardian® substrate.

The bubble process produces biaxially-oriented polypropylene film with balanced orientation in the machine and transverse directions. This bubble process gives the unique physical properties essential for processing banknotes: inherent flatness, stiffness and dimensional stability that ensure efficient conversion through the printing and guillotining processes. It also provides improved stiffness for note accepting and dispensing machines (ATMs).

Biaxially-oriented polypropylene is an extremely tough and resilient material. It is non-porous, non-fibrous, impervious to water and other liquids and, because of these properties, it remains clean much longer than paper substrates. It also has a higher tear initiation resistance than paper. This means that it is very difficult indeed to take a note and try to tear it in half. It is possible, but it requires considerable strength. Furthermore, the substrate does not break down physically with repeated folding like paper notes.

The transparency of the film is the key foundation to Guardian® security. The flexibility to leave areas transparent (windows in a range of complex designs) or to alter the level of opacity of different parts of the note (multitoning) with multiple colours and a variety of impact and non-impact printed security features is the signature strength of this technology. Where



readily available reprographic equipment exists in many homes and offices, this technology has proven to virtually eliminate casual counterfeiting.

The proof of this dynamic innovation is both exciting and secure. A further significant advantage of the film is that it is readily recyclable into a range of useful products such as wheelbarrows, garden products and hard-wearing plastics.

# Polymer and the printing process

■ Enrique Guarnier *Banco de México*

When the Banco de México's banknote production works began to search for a material that would offer greater durability than paper, polymer naturally emerged as an attractive option. But it was not sufficient to know that polymer banknotes were already in circulation in Australia and to analyze a few samples, as answers were also needed to two essential questions: Would polymer cause problems on the production line? Would the new material stand up to local circulation conditions? Analysis of both these aspects revealed the need for a series of printing tests on an industrial scale and a nationwide circulation trial. These tests would determine whether or not polymer was a suitable material for banknote production and whether or not it was appropriate for the local circulation conditions. Now, some ten years after the first studies and tests of alternatives to paper in Mexico, the two lowest denominations of the banknote series are polymer notes and the public use them on a daily basis in their cash transactions. Since 2002 the banknote production works has delivered more than 1,150 million polymer banknotes to the Chief Cashier of the Banco de México. This article describes the main differences between polymer and paper in the banknote printing process.



1. Separation of polymer sheets

## Polymer handling before printing

The main difference between polymer and paper in the printing works is how polymer is handled before and after printing. The printing process must be adjusted to a material whose sheets easily become stuck together and which, at the same time, is less rigid when the sheets are not stuck together. This implies a completely different and more laborious pre-printing process than in the case of paper. The piles of sheets must be separated several times; moreover, once the sheets are separate, loading a 500-sheet ream is more difficult because the sheets are much less rigid than paper. Nevertheless, with training and experience, operators become skilled in handling the new material and are able to provide a continuous feed to the printing presses (see photograph 1).

All printing processes have their own characteristics, but they all share a valve feeder and a sheet stacker at the exit. Both the blowers, which inject streams of air to separate the sheets, and the suction devices must be adjusted in the feeders; in some machines, the brushes and rollers that carry the sheets to the stops must also be adjusted. As polymer is less rigid than paper it tends to become deformed when it reaches the stops and, being non-porous, the sheets stick together when there is no layer of air to separate them. Frequent checks are required at the receiving trays to ensure that any sheets that fall wrongly are corrected. All inks must be checked to determine whether or not adjustments are needed to speed

up the drying process, to reduce sticking and smearing. Some details of each process are described below.

## Peculiarities of the polymer printing process

- **Background (offset):** Although polymer is more uniform than paper, it also tends to shed particles or "flakes" that stick to the blanket and make it necessary to halt the printing process to clean the machinery. In wet offset printing, polymer takes longer to dry than paper. Once printed the sheets tend to stick together (see photograph 2). The Banco de México's banknote production works had to add a suction unit to a machine with an online inspection system (Nota Save) to ensure that the sheets were held firmly in place for transfer of the images.
- **Intaglio printing:** The sheets tend to stick together even more at this stage than in the offset process. Design of the engraved lines may need adjusting, to reduce the amount of ink used and the force with which the sheets stick together. Mexican experience to date is limited to intaglio printing with transparent ink; in 2009 colour intaglio printing on polymer will be tested on an industrial scale for the banknotes to be issued to commemorate the 100th anniversary of the Mexican Revolution.

■ **Numbering:** At this stage, separating the sheets before they reach the feeder is the most laborious process, owing to the strength with which the polymer sheets stick together after intaglio printing (much more so than in the case of paper). Moreover, the amount of ink used for numbering must be adjusted to reduce smearing.

■ **Coating:** In the case of polymer, post-printing coating is not optional, as it is with paper, but rather essential to achieve maximum ink retention and optimum durability. On circulation-damaged polymer banknotes, the printed features (including the opaque ink background used for offset printing, the intaglio printing and the numbering) tend to fade, leaving the transparent base material visible.

There are two possible processes for coating polymer banknotes. The first is to adapt an offset printing machine, inserting ultraviolet drying lamps between the different sections (four in total). As offset printing, for reasons of design, involves printing a very thin layer of ink that is transferred by contact, two coatings are required on each side: the first is a fixer layer and the second provides the matt finish. The Banco de México's banknote production works employed this process in the early years, but it was subsequently replaced as the ink dynamics meant that it was very slow. The method now used is flexography, by means of the KBA-Giori Nota Protector machine

that uses a porous Anilox roller and a flexible laminate to deposit a single layer on each side. This process operates at the same speed as the other machines involved in the production process and requires only two ultraviolet lamps.

### Polymer handling after printing

■ **Automated cutting and inspection:** In order for the banknotes to be cut, the printed ream of sheets must not be allowed to slip. Moreover, the shiny polymer surface may cause problems in the inspection machines' image-capturing machines, and this may halt the automated banknote inspection process. The Banco de México's banknote production works changed the lighting angle of the cameras installed in the machines to reduce the reflection. The shine of the polymer should be checked constantly throughout the coating process to prevent this problem and thus reduce the number of banknotes that are incorrectly sorted. The Banco de México's banknote production works reprocesses the rejected banknotes and recovers approximately half of the total. Productivity in the automated inspection process overall is 17% lower in the case of polymer.

■ **Manual inspection:** Productivity is 30% lower with polymer as manual inspection is a much slower process due to the large number of sheets that stick together. However, if the manual inspection is done between the intaglio printing and the numbering, the sheets can be separated before they reach the numbering machine feeder.



2. Sheets stuck together after printing

■ **Count:** The fact that the sheets stick together also reduces productivity in counting between processes. To assist in this respect, the Banco de México's banknote production works installed a system that would automatically clean the counters and remove all polymer particles.

■ **Design:** Although design does not form part of the printing process *per se*, it is important to note that some design features in polymer may have a significant effect on the printing process. For example, as mentioned above, engraved lines in the intaglio printing process that may need adjustments to prevent the sheets from sticking together.

Polymer is smoother than paper and presents more uniform thickness; this means that lines may be more perfectly defined, producing a clearer image. Nevertheless, the fact that less ink is used, as the substrate does not absorb ink, means that the colours are less intense. This effect is particularly noticeable when a banknote denomination originally designed for paper with paler colours is "polymerized". There are a number of ways to recover the optical sensation of colour intensity: the lines drawn may be made broader, which requires re-origination of the pre-press process; or the inks used may be made darker, although this option may only be used with a limited number of colours. Either of these two alternatives may result in a polymer banknote that is very similar in appearance to its paper counterpart.

### Conclusions

The differences between polymer and paper mean that in order to produce polymer banknotes, minor adjustments are required in printing machines and in training procedures for machine operators. Polymer is perfectly suitable for processing on an industrial scale and results in a quality product that meets public expectations. Productivity declines, especially at first, but this effect gradually diminishes over time; moreover it is offset by the longer average lifetime of polymer banknotes in comparison with their paper counterparts, which means that fewer banknotes need to be produced.

# VI<sup>th</sup> CIGE

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

The VI<sup>th</sup> International Course on Cash Management will be held in Madrid, in the week of 31 May to 5 June 2009, organized by the Banco de España. Registration closed in March and demand has once again substantially outnumbered the places available, meaning that some applicants will have to wait until next year to obtain a place. The Course, which will count on the collaboration of 17 lecturers of 11 different nationalities, will be attended by 25 participants from 18 countries.

The Course organizers have made great efforts to ensure that the excellent level of quality achieved in previous editions is maintained; it is this quality that has made the CIGE the global benchmark in the cash management sector. In addition to the traditional aspects of the programme, this edition will also include several new elements:

- The Course will be held in the Banco de España's residence for employees in Cercedilla, a small town up in the hills 50 kilometres north-west of Madrid.
- From the first day the participants will be divided into groups, each headed by a professional expert. As part of the Course, each team will develop and present a specific project.
- The range of professionals collaborating with the Course, who in previous editions were almost exclusively central bank executives, will be extended to include senior University lecturers, senior members of the judiciary and of the police force and senior executives from the private banking sector. The geographical scope will also be widened, to include not only experts from Latin America, as in previous editions, but also well-known personalities from European central banks and the US Federal Reserve.
- In the space reserved for contemporary topics, a number of leading experts will take on four singular subjects that we are sure will be of great interest:

- Banknote procurement by tendering.
- Islamic banking.
- Human resources management in a Cash Department.
- Response strategies in a liquidity crisis.

As is well-known, the CIGE was created in 2003 by the Banco de España with the collaboration



The Banco de España's residence for employees in Cercedilla.

of the Banco de México and the Banco Central de la República Argentina. The group of central bank sponsors has subsequently grown to include the Banco de la República de Colombia and the Banco de Portugal. The first edition of the Course was held in the summer of 2004;

subsequent editions, each organized by a central bank for professionals from the Cash Departments of the central banks of Latin America, have been held each year.

# International events

## Presentation of Queretaro polymer production plant

The Securrency México, S.A. de C.V. polymer production plant was officially presented to the central banks of Latin America on 27 April 2009. This is the first polymer production plant outside Australia, a joint venture between the Australian company Securrency, which produces Guardian polymer, and the Banco de México, to supply polymer to the central banks of Latin America. The plant, located in Queretaro (Mexico), started up its operations in December 2008; it has 70 employees and occupies a 6,600 m<sup>2</sup> site. The official presentation included a guided visit to the plant,



as well as papers presented by officers from the Reserve Bank of Australia and the Banco de México and other international banknote experts from various central banks.

## Counterfeiting seminar in Rio de Janeiro

A seminar on the fight against counterfeiting of banknotes and coins was held in Rio de Janeiro (Brazil) on 5 - 6 March 2009.

Three fundamental aspects of the fight against counterfeiting were studied at the event:

- banknotes and their graphic design;
- communicating security features to the public;
- policing and the legal grounds for combating counterfeit crime.

The seminar was held with the backing of the CEMLA, which took an active part in organization of the event. It was attended by central bank representatives and by representatives of the Brazilian Federal Police Force and the Banco Central do Brasil's Legal Department. Panel discussions were held, led and coordinated by the representatives of these institutions.



The seminar represents an important milestone for the Banco Central do Brasil, within the framework of the project for modernization of its systems for control, recording and sorting of counterfeit banknotes and its central research laboratory in Rio de Janeiro and in the other nine in operation in the Department's regional offices. Furthermore, the project implies the development of user skills, the creation of a database and data exchange with other institutions. This project has received technical cooperation from other central banks and institutions involved in the fight against counterfeit banknotes and coins.

## XXIII<sup>rd</sup> Intergraf International Security Printers' Conference to be held in Stockholm in 2009

The next edition of the Intergraf Conference will be held in Stockholm (Sweden) on 13 to 15 May 2009. Intergraf represents 25 national printers' federations in Europe and has a special section for printers and suppliers of banknote security features. This event is the main international meeting place for printers of security documents, their suppliers and police and government representatives. The Conference constitutes a forum for discussion of the latest technological

advances in security printing and the fight against counterfeiting. It also represents an opportunity for manufacturers to present their technology to potential clients.

The first edition of the Conference was held in Milan (Italy) in 1976. The last Conference was held in Nice (France) in October 2007; 70 exhibitors took part in the event which was attended by 940 participants from more than 60 different countries.

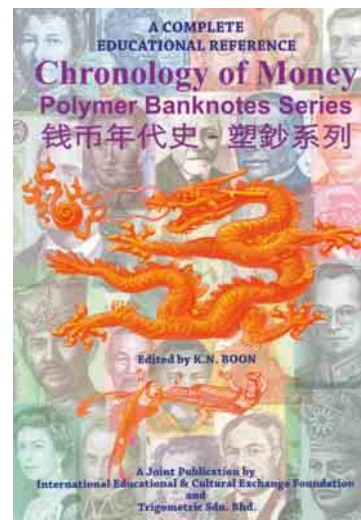
Two other events will be held alongside the Intergraf Conference: the XII<sup>th</sup> International Security Printers' and Suppliers' Exhibition, at which a total of 83 companies and institutions will display their products; and, on 15 May, the V<sup>th</sup> International Stamp Seminar.

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# Publications devoted to cash

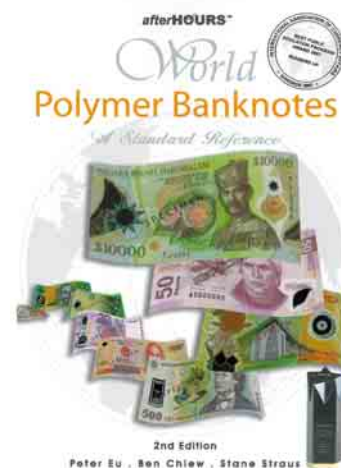
## Chronology of Money. Polymer Banknotes Series

A numismatic publication, divided into two parts, which serves as a reference for an approach to polymer banknotes. The first part presents a brief introduction of the birth of money in China, the history of banknotes in China and the western world and the development of polymer banknotes. The second part is a catalogue of the polymer banknotes issued in a total of 33 countries up to the beginning of 2008, with high resolution images of both sides of the banknotes issued by each country in the context of their respective history, economy and culture. The book, in Mandarin and English, has 312 pages and was published in May 2008 by International Educational & Cultural Exchange Foundation & Trigonometric Sdn. Bhd. It may be obtained at [www.3833.com](http://www.3833.com) or [www.worldbanknote.com](http://www.worldbanknote.com)



## World Polymer Banknotes. A standard reference (2<sup>nd</sup> Edition)

This is the reference book for polymer banknotes, containing illustrations of notes issued by 27 different countries. It provides general information on the banknotes of each country, as well as detailed information on some of the polymer banknotes currently in circulation. The work also presents the security features and different plastic substrates, such as Tyvek, Guardian and hybrid polymer, used to date in polymer banknotes, as well as the printing techniques used in banknote production. The second edition was published in 2007. It has 170 pages and is available from [www.eurekametro.com](http://www.eurekametro.com)



(cont. from previous page)

## Italian Exhibition



The *Genuine and Fake* Exhibition, held in the Museo Storico della Guardia di Finanza in Rome and organized by the Guardia di Finanza in collaboration with the Banca d'Italia, ran from November 2008 to January 2009. Visitors to the Exhibition were able to see a wide range of documentation on authentic Italian banknotes and coins and counterfeits and to

observe how they have evolved over time, thanks to technological advances in security features and as a result of the inventiveness and efforts of counterfeiters in their continuous race to produce perfect copies.

The Exhibition concentrated in particular on the lira banknotes produced by the Banca d'Italia since the beginning of the 20th century and up to the introduction of the euro on 1 January 2002, displaying the wide range of banknote series issued since the central bank was founded in 1894. The

main reason behind the issue of new series of lira banknotes by the Banca d'Italia was the need to underpin public confidence in the currency, as the counterfeiters wasted no opportunity to produce good copies of the notes in circulation.

The Exhibition also displayed the key innovations incorporated by the Banca d'Italia in successive lira banknotes to combat counterfeiting, chiefly intaglio printing, introduced in 1915, the use of luminescent fibres and security threads, the introduction of smaller size banknotes, elimination of the traditional portraits of famous persons to be replaced by an anonymous face in the 1970s and incorporation of state-of-the-art security features in the 1980s and 1990s. The Exhibition also included a section dedicated to the risks of fraud in today's electronic payment instruments.

# Central banking news

## China issues a 10 yuan commemorative banknote

In 2008 the People's Bank of China issued a 10 yuan banknote to commemorate the 29<sup>th</sup> Olympic Games held in Beijing. The chief motif on the front of the note is the National Stadium, while the reverse side depicts an image of the Discobolus. The banknote's dimensions are 148.5 mm x 72 mm. It is printed on paper and incorporates several security features: SPARK ink, a watermark, a Braille denomination feature, a partially-demetalized OVD patch, iridescent patterns, Orlof intaglio printing, colour-shifting holographic windowed security thread and offset micro-text. Six million of these commemorative banknotes were issued.



## New banknotes in Nicaragua in 2009

The Banco Central de Nicaragua is to issue new banknotes as from April 2009. Each different denomination will be of a different size, to make them easier to identify by the visually impaired. The new designs will include images of places of interest in Nicaragua. The 10, 20 and 200 cordoba notes (this latter a new addition in the new series) will be printed on polymer substrate; the 50, 100 and 500 cordoba notes will continue to be printed on cotton paper substrate.

## Euro area comprises 16 countries

On 1 January 2009 Slovakia joined the euro area. The changeover from the Slovak koruna to the euro went smoothly, with the participation of the main stakeholders. The frontloading of euro banknotes and coins to professional cash handlers as from September 2008 was key to this success. The Slovak central bank and Ministry of Economy, the European Commission and the European Central Bank ran a joint information campaign prior to introduction of the new currency. The success of the campaign is reflected in the fact that, in a survey conducted by the Slovak Institute of Statistics, 93% of the population indicated that they had received sufficient information on the euro.



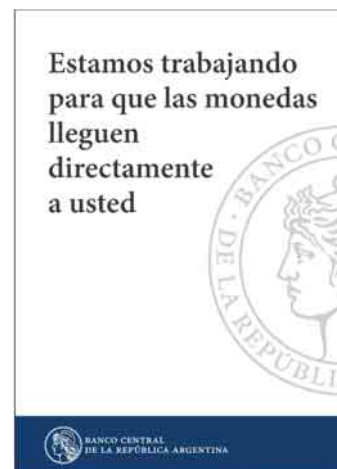
## The Banco Central de la República Argentina solves the problem of scarcity of coins

The Banco Central de la República Argentina has had to deal with a problem of scarcity of coins in the country. Two key factors were responsible for this situation: first, the public's growing preference for coins as a means of payment, as a result of the economic stability achieved in recent years which has meant that the public are now using more coins again; and second, the increase in the price of the base metals of the blanks used for minting coins, which meant that it was more difficult to mint new coins.

The scarcity of coins in circulation led to great inventiveness, ranging from change being given in the form of sweets to a percentage being charged to those requiring coins. In light of this situation and ahead of delivery of coin blanks and coins through the procurement process, the central bank resolved to make direct deliveries to the public, organizing for this pur-

pose a total of eight "cash points" in the three main railway stations in Buenos Aires (Retiro, Once and Constitución). The central bank also reached an agreement with Banco de la Nación Argentina (a State financial agent) and Banco de la Provincia de Buenos Aires for organization of special "cash points" for distribution of coins in 40 branch offices. It also asked for collaboration from all the country's financial institutions to intensify coin deliveries to meet public demand.

The effectiveness of the steps taken and delivery of the coin blanks acquired has meant that in the first few months of 2009 the Banco Central de la República Argentina has returned to a position in which it can gradually meet demand for coins throughout the country.



## Hungary withdraws 1 and 2 forint coins

By means of a regulatory provision of March 2008, the Hungarian central bank has withdrawn from circulation the two lowest denomination coins, that is, the 1 and 2 forint coins. To accompany this move, the Hungarian Parliament issued legislation on rounding off and the central bank asked for collaboration from the commercial sector to prevent

excesses in rounding up of prices. Previous to the withdrawal, an informative campaign was launched to communicate the key message to the general public. The exchange was made gradually: the public were able to exchange their 1 and 2 forint coins in banks and post offices during the first six months from the withdrawal date, and they may continue to do so up to March 2013 in the offices of the Hungarian central bank. Surveys conducted reflected public satisfaction with the withdrawal of these coins, which were of little value and had virtually disappeared from circulation.



## The central banks of Spain and Portugal celebrate the first 10 years of the euro

At the beginning of 2009, the Banco de España and the Banco de Portugal organized exhibitions in three cities in the Iberian peninsula to commemorate the tenth anniversary of adoption of the euro as the single European currency.

The exhibitions organized by the Banco de España were held in February and March. The Madrid exhibition, "The first ten years of the euro in Spain", showed how the Spanish economy has evolved over the last decade, from the point of view of the common monetary policy, banknotes and coins and Spanish society and culture. The Barcelona branch hosted the itinerant exhibition on euro banknotes and coins designed by the European Central Bank and which uses modular panels, videos, interactive touch screens, children's games and showcases with genuine and counterfeit banknotes to present a brief history of money and specific aspects relating to euro banknotes and coins.

For its part, the Banco de Portugal, in collaboration with the Ministry of Finance, presented the itinerant exhibition, "The euro, our money", organized by the European Commission. The exhibition was held in January in the Ministry of Finance in Lisbon. The Banco de Portugal introduced exhibitors specialising in euro banknotes and coins and organized a number of technical seminars for professional cash handlers and students.



# Polymer banknote overview

■ Banco de España *Cash and Issue Department*

Below we present reproductions of some polymer banknotes, issued by the central banks that have collaborated in this issue of BILLETARIA



# Polymer banknote security features

■ Banco de México General Directorate of Currency Issue<sup>1</sup>

Following the same scheme and structure used to describe the security features of paper banknotes (see BILLETARIA, Issue 4), this section presents the security features that have been designed especially for the polymer substrate.

## Multi-coloured substrate



### 1. Multi-coloured substrate (MultiCLR™)

The polymer substrate can be manufactured in a variety of colours; this represents an innovative and effective security enhancement of the banknote. Many colours and design options are available, including a choice ranging from a dual-coloured substrate (in which one side of the substrate is tinted with a different colour to the other side) to a multi-coloured substrate.

## Windows



### 2. Transparent window (WinTHRU®)

The capacity to create a transparent window on a banknote is the key security feature of the polymer substrate. The inclusion of a clear window has allowed many countries to reduce or even eliminate the problem of “casual counterfeiters” who try to copy or scan banknotes on readily available reprographic equipment such as colour copiers or scanners.

The transparent window is an effective security feature that is easy to create in a polymer banknote. One or more windows may be included, of any shape or size, and the windows may even be located near the edge of the banknote, making it easy for the public to check its authenticity.

The opacity of the windows may also vary by varying the number of opacified layers, ranging from total transparency (no layers) to high opacity (multiple layers). The transparent area provided by the windows is also an excellent medium for housing security features such as optical variable inks, diffraction devices or self-verifying features.



### 3. Half-window

The half-window is a variation of the clear window. The difference lies in the fact that the window is opacified on one side of the note only, meaning that one side acts as a glossy surface whilst the other acts as a normal printing surface. The glossy surface is difficult to copy using photocopiers and scanners.



### 4. Diffractive optical element (WinDOE®)

A holographic structure applied to a clear window. When light passes through a diffractive optical element, it is transformed by the structure by diffraction into a recognizable image. The element can be seen using any commonly available light source. The element works best in poor light, as the dark background provides an excellent contrast for the diffracted image to be seen against the light source.



### 5. Printed optical colour shift element (G-switch®)

Created by an optically variable ink printed on the window area in combination with the substrate layers. The optical effect is a change in colour when the banknote is tilted under a light source; this change in colour is easily seen with no need for special equipment or skill, making it easy for the public to recognize.



### 6. Window with embossed intaglio (WinBOSS®)

Based on the ability of the polymer substrate to accept a permanent emboss, this feature is achieved by leaving the engraved areas of the intaglio plate uninked, to create an embossed design during the intaglio printing process. The image obtained is visible in both transmission and reflection light.

1. With the cooperation of Bruno Garoffolo from Securrency International Pty Ltd.



### 7. Window with vignette (WinVU™)

A special structure of lines, created during the design phase, placed in the window; it adds both an aesthetic and a security component, making the window more complex. It thus creates a further degree of difficulty for casual counterfeiters who are already challenged by the task of reproducing a window with complex line structures.

Moreover, this feature may be used together with other complex window features, such as half-windows and shadow images, to make counterfeiting more difficult, more time-consuming and more costly.



### 8. Self-authenticating feature (MicroSam®)

This feature comprises two elements: a screener, printed in the clear window, and an image, printed elsewhere on the banknote. They are both made up of a series of fine lines that cannot currently be photocopied; they are finer than the resolution of the human eye. The device works by revealing a hidden message or code when the screener is superimposed on the image.

The 'hidden image' is difficult to reproduce using electro-photographic means; a moiré effect is produced when it is copied.

## Special inks



### 9. Metallic patch (GOLDswitch®)

A metallic pigment made up as ink and printed on top of the polymer substrate as a patch. This patch may then be used as the platform for other security features such as ICE (intaglio contrast effect) and TIED (transparent intaglio disappearing effect).

ICE involves an intaglio printing image on top of the metallic patch using specially developed intaglio inks. It produces an optically variable colour effect where the colour of the intaglio print intensifies when viewed at a highly oblique angle to the surface of the note. TIED is also printed onto the reflective metallic gold or silver substrate. This combination creates a disappearing effect as the intaglio print is only visible at viewing angles where the background is in high reflection.

The metallic patch is enhanced by the smoothness of the polymer substrate and provides protection against reproduction using four-colour process methods such as colour laser copiers and ink jet printers.



### 10. Iridescent ink (IRIswitch®)

Broad bands of colour or images printed on the substrate with iridescent ink. When the banknote is viewed at different angles the colour and texture of the iridescent ink will change, making it easy to recognize by the public.



## Watermarks



### 11. Shadow image (SHAD H<sub>2</sub>O Switch®)

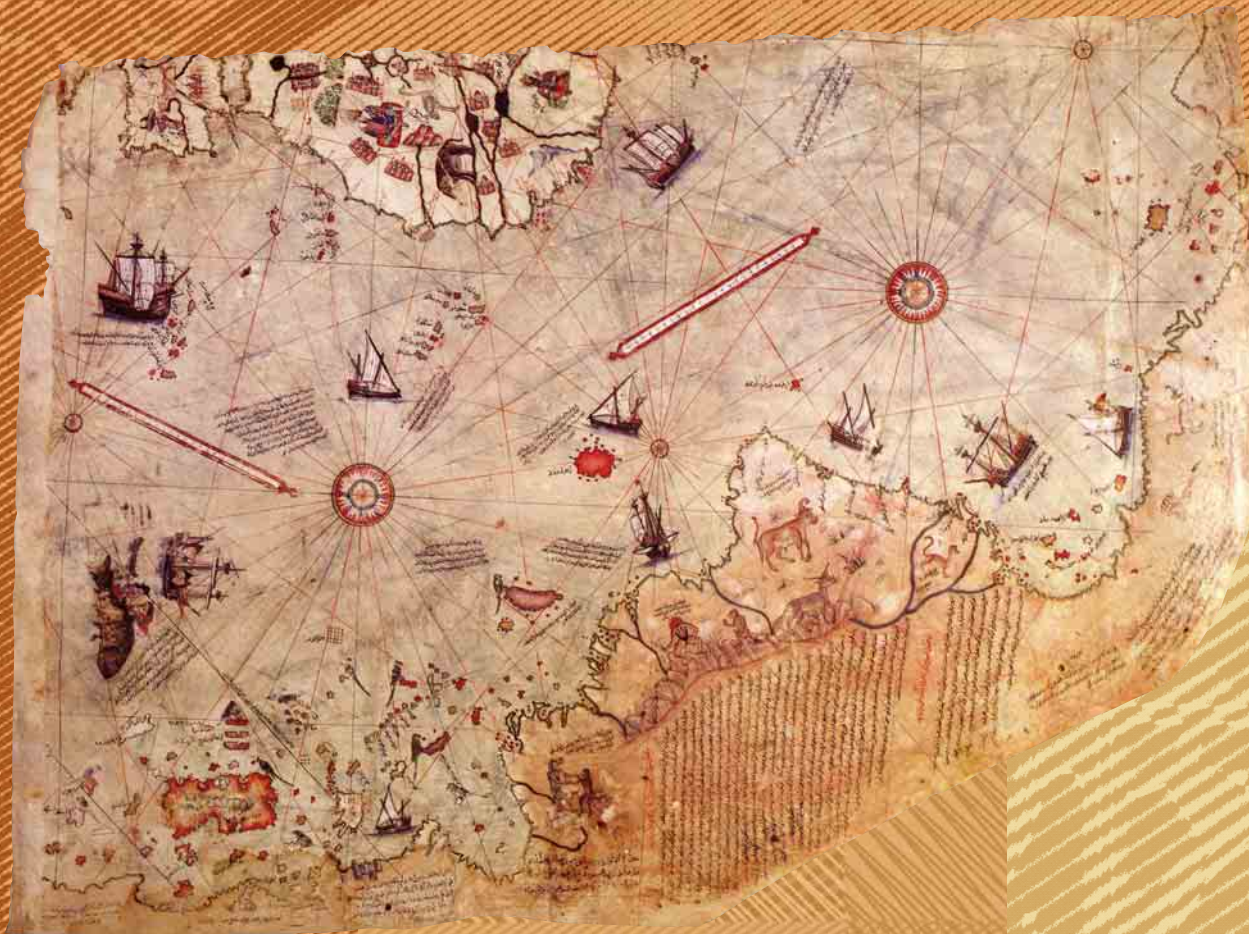
A shadow image on a polymer substrate is similar in effect to a watermark on a paper banknote. It is an excellent optically variable device, not obvious in reflected light but visible when the note is held up to the light. A shadow image is produced by altering the opacity and in some cases the colour of the opacifying layers; it may be a portrait or text or other image.

## Security threads



### 12. Optical security thread (MAGread™)

Threads are one of the most commonly used security features for currency authentication. Threads like those used in paper banknotes may also be used in the polymer substrate. They may contain metallic, magnetic and fluorescent pigments, they may include microtext and they may vary in both shape and size. The production method of polymer substrate permits embedding of straight threads or non-linear complex curved threads. Windowed threads with optically variable ink applied in the windows are particularly effective in discouraging reproduction by colour photocopying or scanning.



The Piri Reis world map, 1513. Topkapi Sarayi Museum, Istanbul (Turkey).

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