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IMPROVING BANK NOTES FOR BETTER COUNTERFEIT DETECTION IN NOTE ACCEPTOR/VALIDATOR MACHINES

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In Australia, as in many countries around the world, bank note acceptors and validators are increasingly being used in a number of applications. Such applications range from the purchase of food/refreshments, transport system tickets and the like to the exchange of one currency for another. As such they provide an important line of defence against counterfeiting. The value of these machines in the fight against counterfeiting is increased if tolerances for the criteria being used to authenticate bank notes can be set as tightly as possible.

In recent times, the Reserve Bank of Australia in association with its subsidiary Note Printing Australia Limited and Securency Pty Ltd have made a significant contribution to improved operation of bank note acceptors and validators through the introduction in Australia of a new series of bank notes printed on a polymer substrate.

Australia was a pioneer in the use of polymer substrates for bank notes, and issued the world's first non-fibrous bank note in 1988. All of Australia's paper bank notes were subsequently converted to polymer substrate over the period 1992 to 1996.

As the issuer of Australia's bank notes, the Reserve Bank of Australia took the decision to move to a polymer substrate for one reason and one reason only – as a means to increase the security of Australia's bank notes. The genesis for Australian polymer bank notes dates back to 1966. At that time, Australia moved to a new series of paper bank notes which included what were then considered to be state of the art security features. Within one year, however, high quality counterfeits of the new $10 note had been produced and widely distributed. Not surprisingly, the Reserve Bank of Australia's confidence in existing bank note technology was severely shaken. It took the view that traditional bank note technology had a limited useful life and that counterfeiting problems could only get worse with further advances in reprographic techniques already on the horizon.

Australia now has a reasonably long experience with polymer bank notes in circulation – around 10 years. With over 20 billion retail purchases each year alone involving currency and with widespread machine handling of bank notes, Australia is proof that polymer bank notes work well in general circulation and during machine processing. We believe that the fundamental reasons for this are the non-fibrous, non-absorbent characteristics of the polymer substrate and the protective coating given to polymer bank notes.

The non-porous and non-fibrous nature of the polymer substrate together with the protective coating mean that polymer bank notes do not absorb moisture and resist staining and accumulation of dirt. Being non-fibrous the polymer substrate does not physically break down or go limp with repeated folding. This results in greater life and durability of polymer bank notes. The more uniform stiffness of the polymer substrate also facilitates easier processing and better presentation of bank notes to sensors/detectors. The surface of polymer substrate is smooth and even and permits greater fidelity with traditional intaglio and offset prints.

Australia's experience with paper bank notes was that the absorbency of these resulted in a number of genuine bank notes exhibiting fluorescent properties leading to their rejection as suspect counterfeits. Evidence was that such bank notes had come into contact with residual detergents in clothing which contained optical brightness.

The protective coating of polymer bank notes, however, assists in machine authentication in a variety of ways. The coating protects the inks carrying machine readable information from wear and tear over the life of the bank note. Machines are required to authenticate bank notes over their full life cycle from new to worn. A large part of the soiling of Australia's earlier series of bank notes arose from their self contamination particularly of their intaglio inks which are often used to carry machine readable features. This self soiling resulted in the need to widen detector/sensor tolerances. Because polymer bank notes resist soiling, self contamination is not a significant problem. With polymer notes information is more securely encapsulated in the bank note for ongoing detection. This allows tighter controls in detectors thus facilitating more accurate discrimination between genuine and counterfeit bank notes. The coating also significantly reduces the amount of dust deposited on sensors/detectors. As well as reducing maintenance requirements, it also enables sensors/detectors to be more finely tuned.

In a survey of suppliers of note validators in Australia in 1998, 82% said that their machines were more efficient following Australia's move to polymer substrate; none said they were less efficient. For some there was a dramatic decline in servicing requirements: for those experiencing improvements, the number of jams declined by 55% and the number of service call outs declined by 15%. The net effect was a noticeable increase in uptime.

Of the respondents who reported an increase in efficiency, all attributed this to the generally better quality of bank notes in circulation, 91% attributed this to less soiling on bank notes resulting in less contamination of belt paths and detector sensors with ink, dirt and dust. Also, 73% said that bank notes fed and counted better because they were stiffer over their working life. Improved feeding results in better presentation of notes at detectors and this, in conjunction with the cleaner environment is more conducive to better measurement.

What is clear from this is that factors such as what bank notes are made of, how well they are made and how well they retain their handling characteristics and security features over the course of their working life can impact on the efficacy of note acceptors/validators. These are factors over which note issuers and printers have some control.

To understand the role bank notes themselves can play in the efficacy of such machines it is useful to briefly highlight some of the things that happen during machine handling.

At a basic mechanical level, bank note acceptors/validators must receive a bank note, count it (if necessary) and transport it. If multiple bank notes are to be accepted this requires the bank notes to be picked singly via a friction or vacuum system then transported to an interrogation area and then deposited in a storage bin from where they may need to be accessed to meet a withdrawal. In this case it is also necessary to have mechanical or optical sensors that measure opacity and check for doubles. Aspects of bank notes that cause the most down time and efficiency losses are tears, holes, corner folds, sticky tape, limpness, uneven surface and stickiness from excessive additive residues such as dried beverages and other sticky substances.

As bank notes are transported they pass a number of detectors or sensors that interrogate the bank note to determine denomination and authenticity. The same detectors may be used for both but not necessarily. Often denomination detection is done by size or optical pattern characterisation of the bank note or via a specific printed marker on the bank note containing machine-readable information such as phosphorescence, magnetics, infra-red, etc. Excessive variations in size either from errors in guillotining of bank notes during production or changes in bank note size during circulation life can create reject problems. Areas that cause the most down time and losses in efficiency are excessively soiled bank notes that include additive soiling from intaglio ink and soiling from human contact such as sweat, general dirt and grime and subtractive abrasion. This type of wear results in a general reduction in the fidelity of the printed images. Additive-type wear causes failure rates in these types of machines because the very material that is the cause of soiling is transferred from the bank note and deposited onto optical sensors and moving parts within the machines, therefore reducing their efficiency. Loss of functionality of these optical sensors results in machine failure and an increase in maintenance time and cost, therefore reducing the total up time of these machines.

Authentication checks involve passing the bank note by a number of detectors or sensors such as coloured filters, infra-red, fluorescence, phosphorescence, magnetics, etc. Depending on the outcome of these checks the bank notes are either accepted or rejected. Areas that cause the most down time and efficiency losses are similar to those for denomination checks. Of particular concern is additive soiling from intaglio inks and dust where the machines are detecting infra-red or magnetic characteristics. Subtractive abrasion results in lack of fidelity and the sensors having to be de-tuned to accept well-worn bank notes. The centre fold line area is of particular importance as it is the most harshly treated area of a bank note for abrasion. Similarly, fluorescent and phosphorescent characteristics can be quite different on mint condition bank notes and well-worn bank notes. The intensity of the signals diminishes dramatically upon additive soiling or heavy abrasion removing part or all of the above features. In addition, high reject rates can occur if during bank note production there is excessive variability in the positioning of features or in the ingredients that generate the signals to be measured.

In discussion with suppliers of bank note acceptors/validators and others we have been told that initiatives which bank note issuers and printers can take to assist include:

- use of a substrate that is tough, resistant to tearing, and maintains a uniform stiffness over its life;
- tighter bank note specifications for the production of bank notes both in terms of materials used and tolerances for size, colour and registration;
- more durable bank notes including improved consistency of life across various security features; and

- improved design that incorporates machine readable features or design elements in ways and in positions that avoid damage and facilitate better detection.

Some of the progress reported earlier with the performance of polymer notes in note acceptors/validators is because they offer advantages in some of the above areas. Polymer substrate is very tough and durable with a more consistent stiffness throughout its life. The non-fibrous, non-porous nature of the substrate and the overcoat given to these notes improves durability and reduces soiling generally and specifically self-soiling from intaglio inks that often contain the machine-readable information. These same aspects result in much less contamination of the note acceptor's/validator's mechanical and detector systems.

Conclusion

With the increasing use of note acceptors/validators there is increasing pressure on note issuers and printers to:

- provide notes with a range of machine-readable features incorporated appropriately into note designs;
- produce notes with greater uniformity across a production run and between production runs;
- produce notes that retain their characteristics more uniformly throughout their working lives.

It is through these improvements that the efficacy of these machines can be enhanced. By improving quality and consistency, both in manufacture and in life performance, detectors in such machines can be tuned to the highest level of discrimination between counterfeit and genuine notes.

We believe that the use of polymer substrate for the manufacture of Australia's bank notes because of its non-porous and non-fibrous characteristics and the overcoating of those bank notes, has significantly improved the capability of bank note acceptors/validators to discriminate between genuine Australian bank notes and counterfeit notes.

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