

# Advances in Digital Imaging and their Impact on the Bank of Canada's Bank Note Image Distribution Policy

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## Abstract

In recent years, the availability of high quality, inexpensive scanning, image editing and printing equipment has markedly increased. Images of bank notes, once difficult to obtain, are now readily available. As the availability of images has increased, so has the risk of misuse for the purpose of counterfeiting. As a direct consequence of the widespread availability of digital imaging capabilities to the general public, the Bank of Canada has made several modifications to the images it distributes, the procedures governing who is allowed to use them and the restrictions placed on their use. This paper describes circumstances which led to the development of the Bank of Canada's image distribution policy, the library of images, and the adoption of digital watermarking technology.

## Canadian Counterfeiting Situation

In recent years, significant advances have been made in reprographic technologies. A mere 15 years ago, scanners, photocopiers, printers and computers were prohibitively expensive. In today's market, high-performance computers, scanners and printers are now within a price range that members of the general public can afford. Accessibility to technology has had an important impact on the volume of Canadian counterfeits.

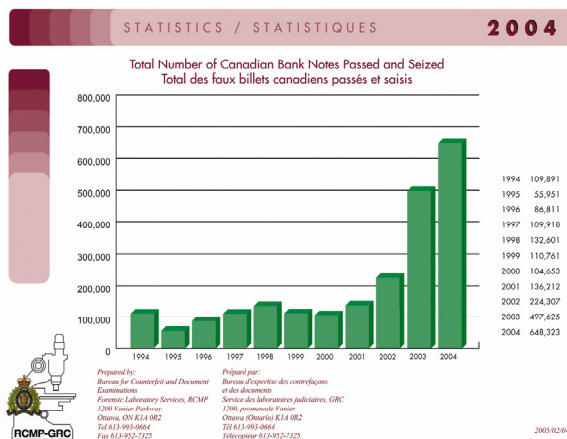


Figure 1. Volume of counterfeit bank notes passed and seized, 1994-2004.<sup>1</sup>

Formerly, currency counterfeiting necessitated the use of large, expensive presses and bank note lithographic plates expertly generated by hand. This technique, formerly the only method of producing counterfeit notes, now represents less than 0.1% of Canada's counterfeits while the majority of counterfeits are manufactured by inkjet printing.

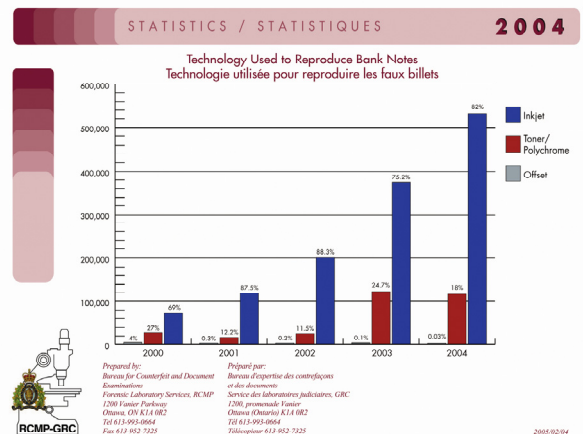


Figure 2. Technology used to reproduce bank notes in Canada, 2004.<sup>1</sup>

The rise in counterfeiting activity led the Bank of Canada to initiate and participate in many initiatives, projects and partnerships. The Bank is now equipped with an in-house Bank Note Evaluation Centre where counterfeits can be analysed and evaluated. The Bank also collaborates with law enforcement officials to promote counterfeit awareness and compliance with Canadian laws on bank note reproduction. Among the most important initiatives is the development of the Bank Note Communication and Compliance Team.

## Development of the Bank Note Communication and Compliance Team

Prior to 1997, the Bank of Canada shared a common view with other central banks: information on security features, whether overt, machine readable or covert, was best kept secret. It was believed that information released to the general public would make its way to counterfeiters. It would help counterfeiters produce high-quality counterfeits, which would be harmful to the Bank's reputation.

At that point in time, the only information available on bank note authentication was in the Royal Canadian Mounted Police guide on bank note authentication, which included crude, hand-drawn likenesses of Canadian bank notes in circulation.<sup>2</sup>

Since then, the Bank's general opinion on information dissemination has changed drastically. It is now understood that one of the most important "security features" in the fight against counterfeiting is a well-informed public. To be able to authenticate bank notes, cash handlers, law enforcement officers and members

of the general public must recognize and understand bank note security features, particularly those of an overt nature.

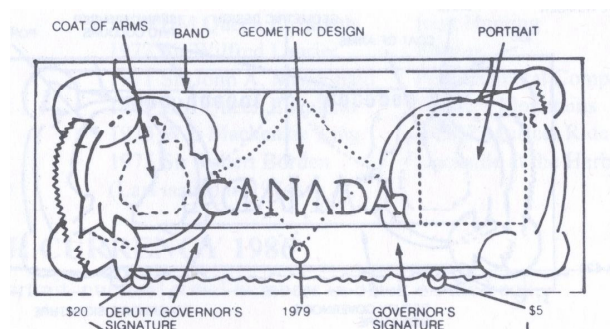


Figure 3. Crude, hand-drawn bank note likeness provided to the public in 1992.<sup>2</sup>

To respond to this educative need, the Bank created the Bank Note Communication and Compliance Team in 1997. It contributes to consumer confidence in bank notes and the strengthening of bank note security by executing communication and compliance strategies that enable Canadians, financial institutions and the retail sector to recognize and transact genuine bank notes. This is achieved through the development of a broad range of communications products and services that raise interest and awareness of security features found in Canadian bank notes. In addition, the team works closely with key partners within the Bank, law enforcement community, national business community and the banking industry to implement joint initiatives that address counterfeiting and other infringements of bank note security.

However, education on bank note security features has revealed the risks associated with image distribution. These risks prompted the development of the Bank's image distribution policy, and the accompanying image library.

### The Bank's Image Reproduction Policy

Some central banks place no restrictions on the reproduction of bank note images, while others completely prohibit bank note image reproductions of any kind.

According to Section 457 of the Canadian Criminal Code: "Anyone who makes, publishes, prints, executes, issues, distributes or circulates, including by electronic or computer-assisted means, anything in the likeness of a current bank note is guilty of an offence punishable on summary conviction and is liable to imprisonment for a term not exceeding six months and a maximum fine of \$2,000".<sup>3</sup>

The law also states that it is not an offence to reproduce a bank note if one has the Bank's permission. In addition, no person will be convicted of the above offence if the printed likeness respects certain size and colour restrictions.

The Bank of Canada owns the copyrights to Canadian bank notes as well as their individual design elements. Section 42(1) of the Copyright Act states that: "It is an offence to knowingly make for

sale, sell, import for sale, or by way of trade, expose for sale or exhibit a copy of work that infringes copyright. Anyone who commits this offence is punishable on summary conviction and is liable to imprisonment for a term not exceeding six months and a maximum fine of \$25 000. If the Crown proceeds by indictment, the offender is liable to imprisonment for a term not exceeding five years and to a fine not exceeding \$1,000,000. On conviction, the court may order the destruction or delivery up of all infringing copies and all plates predominantly used for making infringing copies".<sup>4</sup>

To avoid the risk of being charged with a criminal offence, and the risk of civil action, anyone wishing to reproduce a bank note image must contact the Bank of Canada to obtain reproduction rights.

The Bank considered various options while developing its image reproduction policy, including a total ban on Canadian bank note image reproduction. This stance was later discounted on the basis that it stands contrary to the Bank's mandate of educating the Canadian public on overt security features. The Bank of Canada recognises that currency is an important symbol in Canada, and that individuals may wish to reproduce bank note images for legitimate reasons – usually advertising, education or bank note collecting.

The policy states that the Bank may, at its sole discretion, consent to the reproduction of images if there is no risk that the reproduction could be mistaken for a genuine note or be misused by counterfeiters. The proposed image must pose no reputation risk to the Bank, and must not tarnish the dignity and symbolic importance of bank notes to Canadians.

The library images are drawn from conceptual models, used in the design development of bank notes. The conceptual model files contain no linework, and no microprinting. The colours do not precisely match those of genuine notes. The images also bear multiple bright, large markings indicating that the image is a specimen, and that image copyrights are owned by the Bank of Canada. These factors lessen the possibility that library images could be used as a starting point for counterfeits.

The Bank's policy strikes a middle ground, recognizing that bank notes are an important cultural, national symbol and that people often have legitimate reasons to reproduce bank note images.

To ensure close monitoring if distributed images, the Bank introduced a digital watermarking plan.

### Digital Watermarking

Prior to the implementation of the policy, when cases of bank note image reproductions were observed, the Bank's approach was passive. Other than reporting the image misuse to the Royal Canadian Mounted Police, there were no initiatives to remove the images from circulation.

The policy now clearly states that all individuals wishing to use images of Canadian bank notes must obtain the Bank's permission; support of this policy requires a system by which misuse of the supplied images can be confirmed.



Figure 4. Digitally watermarked library image of the Canadian Journey series \$20 provided to the public in 2004

The image distribution policy requires the addition of a robust, covert tracking mechanism, unique to each image while maintaining the quality level of the conceptual images supplied by the Bank, as this otherwise could cause publication houses to discard the distributed images. While not substantially changing the image, the mechanism must be able to withstand anticipated manipulations and still be present in second-generation prints.

The digital watermark solution is a technology that provides the required security for distributed digital images. It is a security feature that enables the addition of a unique, covert and machine-readable data element into digital images prior to their distribution. The digital watermark is secure as it is not perceptible to the human eye, nor can it be deciphered by analysing the watermarked image. The original unmarked images are safely stored on a secure network which is physically and electronically protected.

The digital watermarking system purchased from Digimarc® enables the inclusion of a unique numeric digital code within each distributed bank note image. This code is stored in a database for future reference. The associated data include the date of the request, the organisation or individual making the request, the parameters of the image reproduction as well as the date by which electronic copies of the image must be destroyed. Requestors of bank note images are advised in advance that tracking information will be embedded in the images supplied to them, and the data provided by each user follows the provisions of the Privacy Act.

Digital watermarks have been embedded in Canadian bank note images since November 2004. So far, there has been no negative comment on the quality of the images. This leads to the belief that the digital watermarking system does not have a detrimental effect on image quality, nor does it seem detectable.

Since the digital watermarking initiative started, a number of printed publications have been collected and analysed to test the presence and robustness of the digital watermark. The presence of a watermark was detected in all cases. However, for optimum detection of the unique digital watermark code, the embedding strength must be tailored to the intended use. For example, images that are printed in newspapers must be embedded at higher strengths than those intended for use in magazines, brochures, or other high-quality prints.

Redundancy is introduced by repeating the digital watermark over the entire landscape of the image. It is therefore possible to read the embedded data from a portion of the image that is approximately 15 - 20% of the full bank note. This implies that if a portion of the image (for example, the portrait) is substituted to produce a parody of a note, or if only a portion of a bank note image is used in an advertisement, it remains possible to track the original image recipient.

If the released digital images were misused in publications or used in the creation of counterfeit bank notes it would now be possible for the Bank track the misused images. This is clearly an asset in investigations, be they criminal or civil, as it may help identify an individual involved in criminal activity.

Image misuse by legitimate bank note image users can also be tracked. For example, when the Bank distributes images for publication, a time restriction is placed on image use. Should an image be published past its allowed timeframe, the Bank is now in a position to identify the image misuse and react accordingly.

While the system provides excellent tracking abilities, it has limitations. Among them, the ability to read the digital watermark in second and third generation prints (reprints from a scanned image) is dependent on the resolution of the scanning and printing operations. Second generation prints can be successfully read provided the scanning and printing operations are performed at medium to high resolution.

## Conclusion

The advances in technology have made images of bank notes, formerly difficult to obtain, readily available. High counterfeiting levels have forced the Bank to change its policy on education and bank note image distribution. The Bank of Canada has taken steps to enforce its rights to own and control the images of its bank notes, while promoting security feature education with images that are educational, but worthless to counterfeiters. Image ownership rights are monitored and enforced through digital watermarking technology. The initiatives discussed serve both to elevate the dignity of the bank notes themselves and to discourage misuse of their likenesses, whether for counterfeiting or for other undignified purposes.

## References

1. Bureau for Counterfeit and Document Examinations, Forensic Laboratory Services, RCMP
2. Counterfeit Detection, Royal Canadian Mounted Police, Public Affairs Directorate for Economic Crime Directorate, PAD 373, Minister of Supply and Services, Canada (1992)

3. Canadian Criminal Code (R.S. 1985, c. C-34) updated 2004
4. Copyright Act ( R.S. 1985, c. C-42 ) updated 2004

## Author Biographies

*Martine Lacelle holds a degree in Chemistry with a specialisation in Computational Chemistry from the University of Ottawa. She joined the Bank of Canada's Currency Development Team in 2004. Since, she has been involved in the research, development and adversarial analysis of new and current security features, the evaluation of counterfeit notes, the assessment of counterfeiting materials and technology, and the development of the image library.*

*Before joining the Bank, Michael Duncan had been a member of the Royal Canadian Mounted Police (RCMP) since 1974. He was appointed Senior*

*Analyst in the Bank Note Communication and Compliance Team at the Bank of Canada in 2003. In this capacity, he works with law enforcement agencies and prosecutors to support their efforts to combat counterfeiting by developing and delivering training programs, sharing information about trends in counterfeiting, and coordinating the exchange of information.*

*Dr. Sara Church has a PhD in physical chemistry from Oregon State University. From 1988 to 2001, she worked at the Bureau of Engraving and Printing, mainly in the Advanced Counterfeit Deterrence group. She joined the Bank of Canada in late 2001. Her particular interests are the evolution of digital technologies and counterfeiting threats they pose, counterfeit analysis and implications for currency design and quantitative evaluation of public knowledge and perception of bank notes.*