

MICROSCOPIC EVALUATION OF THE SECURITY PRINTING TECHNIQUES APPLIED ON HISTORICAL BANKNOTES – CASE STUDY: SERBIAN DINAR BANKNOTES FROM 1905 TO 1996

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Abstract: This paper presents a part of interdisciplinary research of banknotes issued by the National Bank from the year 1905 to 1996. A complex history of the Serbian state and monetary transformations of the National Bank during the 20th century involved manufacturing banknotes in different printing factories in Europe and the United States of America, which considered different techniques of printing and the application of different security features. Therefore, this research aims to demonstrate and evaluate the applicability of the optical microscope to identify the printing technique used for manufacturing, as well as differences in the printing process and the application of security features in the historical banknotes of Serbian dinar currency from different periods. For each analyzed specimen, several different features of the banknotes (watermark, serial number and security printing techniques on 6 to 10 points) were considered. Differences were revealed in the security printing technique processes through seven states and monetary transformations with special emphasis on the differences observed within the period from 1920 to 1944. These observations have raised some authenticity questions and provided common ground for numismatic researchers and scientists to get interested in developing an analytical protocol for evaluating the security printing process applied on historical banknotes. The methodological complexity of this research raises the need for the development of a compiled database of archive data on the issuance, manufacturing, graphic design, and security printing techniques used to produce banknotes. Therefore, the obtained results can be used to draw comparisons between periods of the establishment of monetary unions in Eastern and Central Europe, especially in the Republic of Serbia, and to protect the monetary cultural heritage from counterfeiting.

Keywords: security printing, security features, banknotes, Serbian dinar, numismatics, National Bank, optical microscopy

INTRODUCTION

For the past four decades banknotes have been largely studied to obtain information about the national identity and building the design and interpretation of narratives of national iconography and symbols on banknotes in Central and Eastern Europe and the United States.¹ The methodological complexity of undertaking this research combines and emphasizes the need for the development of a compiled database with archive data on the issuance, manufacturers, graphic design, artists, and the usage of Optical microscopy to ensure security printing techniques. Therefore, the obtained results can be used to draw comparisons between the periods of establishment of monetary unions in Eastern and Central Europe, especially in the Republic of Serbia, and to understand the printing technological progress and protect the monetary cultural heritage from counterfeiting.² In the present paper, a study is reported that was carried out by means of Optical microscopy on ten banknotes from different state and monetary periods from 1905–1996. For each specimen, several different features of the banknotes (watermark, serial number and security printing techniques on 6 to 10 points) were considered. Differences were revealed in the printing technique processes regarding different manufacturers on two banknotes from the period of the Kingdom of Serbs, Croats and Slovenes and the Kingdom of Yugoslavia. Nowadays, banknote recognition software is programmed to check the print quality.³ However, in the case of historical banknotes, most features remain to be authenticated through manual inspection⁴ and knowledge and experience of the numismatic expert. Since the first paper money production appeared in Europe in the 13th century, the banknotes have kept several prototypical elements, like e.g. a signature, date and a watermark.⁵ The first multi-tone watermarks were

- 1 See: G. Jauković "The role of Mihailo Valtrović and Dragutin S. Milutinović in the creation of national visual identity on Kingdom of Serbia banknotes in the period of 1884–1900", *Zbornik Matice Srpske za likovnu umetnost* 47, 2019, T. Unwin and V. Hewitt, "Banknotes and national identity in central and eastern Europe", *Political Geography*, Vol. 20, Issue 8, 2001, 1005–1028, [https://doi.org/10.1016/S0962-6298\(01\)00042-7](https://doi.org/10.1016/S0962-6298(01)00042-7) [12/04/2019]; G. Emily "Ornamenting the facade of hell: iconographies of 19th-century Canadian paper money", *Environment and Planning D: Society and Space* Vol. 16, 1998, 58–70. <https://doi.org/10.1068/d160057> [28/10/2019] E. Helleiner, "National Currencies and National Identities", *American Behavioral Scientist*, Vol. 41, No. 10, 1998, 4009–4036, <https://doi.org/10.1177/0002764298041010004> [07.05.2019]; J. E. C. Hymans, "The Changing Color of Money: European Currency Iconography and Collective Identity", *European Journal of International Relations*, Vol. 10, No. 1, (2004), 5–31, DOI:10.1177/1354066104040567 [07/05/2019] J. E. C. Hymans, "East is East, and West is West? Currency iconography as national – branding in the wider Europe", *Political Geography*, Vol. 29, No. 2, 2010, 98–108, <https://doi.org/10.1016/j.polgeo.2010.01.010> [07/05/2019] J. Penrose, "Designing the nation. Banknotes, banal nationalism and alternative conceptions of the state", *Political Geography* 30, 2011, 429–440, <https://doi.org/10.1016/j.polgeo.2011.09.007> [07/05/2019] H. Heij, "Designing Banknote Identity", *DNB Occasional Studies*, Vol. 10, No. 3, 2012, p. 5–392. <https://www.dnb.nl/media/jlbps012/201208nr32012designingbanknoteidentity.pdf> [04.07.2019]
- 2 G. Jauković, "Advantages and disadvantages of Raman spectroscopy in testing paper banknotes", *Tehnički glasnik*, vol.13, br. 3, str. 226–229, 2019. <https://doi.org/10.31803/tg-20190328155758>
- 3 See: Foster Freeman technology for questioned document examination booklet www.fosterfreeman.com
- 4 J. Chambers and W. Yan, A. Garhwal, M. Kankanhalli, Currency Security and Forensics: A Survey. Digital currency forensics, 2013. pp.2. <https://core.ac.uk/download/pdf/56364077.pdf> [02/04/2019]
- 5 H. Heij, "Designing Banknote Identity", *DNB Occasional Studies*, Vol. 10, No. 3 2012, p. 61. <https://www.dnb.nl/media/jlbps012/201208nr32012designingbanknoteidentity.pdf> [04/07/2019]

issued by the Banque de France (*BdF*) in 1829, followed in 1855 by the first shaded watermark in the banknotes of the Bank of England.⁶ Security printing processes can start with simple techniques such as printing on special paper or including watermarks.⁷ Usually placed in an image-free area, watermarks represent the most known security feature of a banknote.⁸

Historical research of Archive data from BdF and NBS

The economic conditions and diplomatic contacts by the end of the 19th century (1886) enabled the cooperation of the Privileged National Bank of the Kingdom of Serbia (PNBKS) with the National Bank of France (*BdF*).⁹ As far as we know, no scientific study of this kind has been carried out on the Serbian dinar currency from mid-20th century. Having in mind that this is the first time for Optical microscopy to be used for the study of historical banknotes of this source, we intend to gather information significant for a more comprehensive study of the banknotes from the end of the 19th century issued by the PNBKS (1884–1918), from the 20th century following World War I, when the NBKSCS was established, as the legal successor of the PNBKS (1920–1929), later in the KYU and during World War II (April 1941–October 1944) through the period of German occupation of KYU when the NBKYU was liquidated by the German Reichsbank, and the Serbian National Bank (SNB) was established.¹⁰ In the aftermath of the Second World War, starting from 15 January 1946, our central bank changed its name into the National Bank of the Federal People's Republic of Yugoslavia, and in 1963 into the National Bank of Yugoslavia.¹¹ Evaluation of Archive data enabled identifying the security printing techniques and inks that were used. Analyses were done in the area of the physical properties of the paper, the quality of the printing technique, and the characteristics observed under the Optical microscope.¹²

6 *Ibid.* p. 118.

7 C. Nakamura, The Security Printing Practices of Banknotes, *Project theses*, Graphic department at the Faculty of the Graphic Communication, California Polytechnic State University, San Luis Obispo, 2010, p. 5. <https://core.ac.uk/download/pdf/19136612.pdf> [07/03/2020]

8 H. Kipphan, *Handbook of print media: technologies and production methods*, Springer, 2001. p. 423. [07/03/2020]

9 The PNBKS released the Second issue of the 10-dinar banknote payable in silver in 1887. The printing was entrusted to the *BdF* for the first time. Furthermore, in 1903/05 the process of manufacturing the 100-dinar banknote was again entrusted to the *BdF*. The French style of formation and visual design for the paper money of the NB was dominant during the end of the 19th century, up to the 1930s. See: G. Jauković, "The role of Mihailo Valtrović and Dragutin S. Milutinović in the creation of national visual identity on Kingdom of Serbia banknotes in the period of 1884–1900", *Zbornik Matice Srpske za likovnu umetnost* 47, 2019.

10 В. Дугалић и др., Народна банка 1884–2004, Београд, 2004, 123–144.

11 М. Šojić, 85 years of economic and monetary research in the National Bank of Serbia, *Bankarstvo*. Vol. 6. 2013. p. 187.

12 J. M. del Hoyo-Meléndez and K. Gondko, A. Mendys, M. Król Król, A. Klisinska-Kopacz, J. Sobczyk, A. Jaworucka-Drath, A multi-technique approach for detecting and evaluating material inconsistencies in historical banknotes. *Forensic Science International*, 2016, 266: 329–337 <https://doi.org/10.1016/j.forsciint.2016.06.018>

MATERIAL AND METHODS

Investigation of the printing techniques applied on historical banknotes

Historical research regarding issuing and manufacturing of the investigated samples was undertaken with the valuable archive documents from the Archive of *BdF* (ABdF) and the Archive of the NBS (ANBS). In order for the mentioned research goal to be achieved, the methods of content analysis, case method, comparative historical analyses and causal analyses were mainly used. The banknotes were visually examined and the printing techniques for manufacturing were revealed, parallel the analyses of security features. An optical microscope Olympus CX41 with digital camera Olympus UC30 was used to determine the differences in the printing process and the application of security features on ten banknotes, manufactured within the *BdF* from 1905–1929, in the American banknote Company (ABCo) in New York (1919/20), in Institute Goznak (1944) in the USSR and Institute ZIN within the NB in Belgrade from 1931–1996. Ten categories of banknotes were examined: 100-dinar B421 issued in *BdF* in 1905, 10-dinar AK839986 issued in ABCo in 1919/20, 100-dinar X694, issued in 1925 in *BdF*, 50-dinar Љ0617 issued in ZIN within NBKYU in 1931, 500-dinar Ж0063 issued in ZIN within Serbian Bank in 1941, 50-dinar ГВ 179427 issued in Goznak USSR, 5000-dinar AM268424 issued in ZIN within NBFNRY in 1963, 500-dinar DV495478 issued in ZIN within NBFNRYU in 1970, 5000-dinar AA 2886033 issued in ZIN within the NBSRYU in 1991 and 50-dinar AF 7299776 issued in ZIN within NBYU in 1996. This investigation also presents a reliable system of performance, which can be verified by using simple diagnostics to check the status of the genuine and counterfeit historical banknotes.¹³

Investigation of printing techniques on banknotes in the period of the Kingdom of Serbia:

According to Archive data and literature¹⁴, the National Assembly adopted the amended Law, signed by the King on 31 March 1904, in order to issue new PNBKS banknotes for circulation. It was only then that the PNBKS's Board of Directors decided to issue the 100-dinar banknotes payable in silver, and after several months duly informed the Minister of National Economy that *BdF* would be the one to design and print these banknotes. In mid-May 1905 the Minister approved the submitted design for the banknote, but its printing was, nevertheless, prolonged until 1906. The PNBKS announced that the banknote would be put in circulation on 25 April 1907.¹⁵ The Optical microscopy analysis on the 100-dinar banknote signed with the serial number B421 (Figure 1) and the design of "Lady Heroine", which is a personification of Motherland of the Kingdom of Serbia, released in 1907 by the PNBKS in Belgrade, proved this banknote to be a typical example of use of *BdF* – French two-color banknote.¹⁶ At the beginning of its production of banknotes the

13 A. Klisińska-Kopacz and K. Lech, J. M. Hoyo-Meléndez, A. Mendys, A. Jaworucka-Drath, B. Łydźba-Kopczyńska. Provenance studies of Kościuszko banknotes – One of the oldest paper banknotes in Europe– Using Raman spectroscopy in conjunction with other analytical techniques. *Journal of Raman Spectroscopy* 2020, 51 (9), 1903–1912. <https://doi.org/10.1002/jrs.5710>

14 See: Ž. Stojanović, *Papirni novac Srbije i Jugoslavije*, Beograd, 1996., J. Хаџи Пешић, *Новац Србије 1868–1918*, Београд, 1995.

15 See: J. Хаџи Пешић, *Новац Србије 1868–1918*, Београд, 1995, S. Pantelić, *Novčanice od 20 i 100 dinara iz 1905. godine. Bankarstvo*, 44(4), 2015. p.136–143.

16 M. Daspre, *Trois siècles de billets français*, Hervas, 1989. pp. 91–100.



Fig. 1

BdF used two plates of security inks for printing.¹⁷ The process of applying security ink layers is a combination of printing techniques that can be attributed to offset lithography which simulates 3-D effects. It was observed that the examined banknote has a combination of blue and red security ink layers applied by involving offset lithography which creates images by using a line-structure formation of vertical and diagonal lines. The printing form was made from a precise drawing of fine lines. Among the most characteristic elements of the banknote are the serial numbers and signatures seen on the examined area, printed in letterpress by special numbering presses. Letterpress is one of the oldest printing techniques based on Johannes Gutenberg's invention of moveable type.¹⁸ Metal plates with raised images are inked and pressed against the substrate. Therefore, the incorporation of security features aimed at preventing counterfeiting is certainly an indispensable part of the process of banknote production, the results of which is the final formation of the appearance of the banknote. Security printing processes can start with simple techniques such as printing on special paper or including watermarks. In early 20th century the process of production of watermarks in *BdF* included only areas of thin paper, made by modifying the mold of the paper, and creating light watermark areas.¹⁹

The 100-dinar banknote bears the date of 5 January 1905. The left side of both the obverse and reverse features the name of the drawer, Georges Duval, Fecit,

¹⁷ *Ibid.* 96.

¹⁸ C. Nakamura, *The Security Printing Practices of Banknotes*, Project theses, Graphic department at the Faculty of the Graphic Communication, California Polytechnic State University, San Luis Obispo, 2010, pp. 12–19. <https://core.ac.uk/download/pdf/19136612.pdf> [07/03/2020]

¹⁹ T. Gaston, *Banque de France Two centuries of history*, Banque de France, 1999. p. 35–46.



Fig. 2

and the right side the name of the engraver, Ernest Florian, SC. The signatures on the banknote are those of Marko Stojanović, Member of Administration and Tihomilj J. Marković, Governor of the PNBKS. The paper of the banknote contains the watermark in the shape of Mercury's head.²⁰

Printing techniques in the period of the Kingdom of Serbs, Croats and Slovenes

Following World War I, on 26 January 1920, pursuant to the Law on the NB, the NB of the Kingdom of Serbs, Croats and Slovenes (NBKSCS) was established, as the legal successor of the PNBKS.²¹ One of the major challenges in the newly founded KSCS was the exchange of Austro-Hungarian crowns for dinars and issuing new banknotes for circulation.²² After the First World War, the first banknote of the newly established NBSCS, the 10-dinar banknote with the serial number AK 839986 (Figure 2), was produced by the American Banknote Company (ABCo) in New York. The banknote

20 S. Pantelić, Novčanice od 20 i 100 dinara iz 1905. godine. *Bankarstvo*, 44(4), 2015. 136–143.

21 At the beginning of World War I, on 13 June 1914, the Privileged National Bank of the Kingdom of Serbia was evacuated from Belgrade, via Thessaloniki, to Marseille, France, where it remained until the war was over, when it returned to Belgrade, on 16 February 1919. In this period the National Bank's assets were almost completely preserved, especially gold and silver, as the foundation for the national currency – the dinar. See: В. Дугалић и др., *Народна банка 1884–2004*, Београд, 2004. p. 67.

22 The amount of crowns circulating at the time in the territories which were integrated into the Kingdom was estimated at around 8–10 billion. To help resolve the problem, the government took out a loan to purchase a portion of that amount. The performed conversion of Austro-Hungarian crowns increased the amount of money in circulation in the Kingdom of SCS, which resulted in an inflationary surge. It was not until 1923 that the dinar was first stabilized and inflation reduced. See: Ж. Стојановић, *Пайирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994. 81.

is dated 1 November 1920, and it was released on 5 August 1922.²³ The numismatists named it the American because of its appearance, since it was modeled after the dollar, featuring several shades of blue.²⁴ The choice of the company followed the recommendation of the *BdF*, which at that time, due to the occupancy of its capacities, could not accept the task of printing this banknote. The American, made in the characteristic dollar style, is also recognizable by its vivid shades of blue and the thick paper. The size of the drawing without borders on the obverse side of the banknote is 142×81mm, and on the reverse 135×80mm. The name of the *ABCo* was printed on both the obverse and reverse sides, below the drawings.

The Optical microscopy analysis on the 10-dinar banknote signed with the serial number AK 839986 and the design of the “Man turning wheel” vignette, which represented personification of the progress in newly state – KSCS, released in 1925 by the NBSCS, proved this banknote to be a typical example of use of American style multicolor banknote. This banknote does not have a watermark and does not include the names of the author of the drawings or the engravers.²⁵ The assessment of the quality of the banknote was given in 1926 by the Banknote Department of the NBSCS, in one of its reports. It pointed out that the banknote was well made and that it was, therefore, hard to counterfeit, that the paper was very strong, but prone to losing its firmness after a short use. In this case, the application of security ink layers has a combination of printing techniques that can be attributed to intaglio printing and offset lithography which simulates 3-D effects. It was observed that the examined banknote has a combination of light and dark blue security ink applied by using intaglio and for red and green security inks layers involved offset lithography which creates images by using a line structure formation of vertical and diagonal lines. Intaglio printing (gravure printing, steel engraving) is currently an obligatory way to protect banknotes and other types of products in majority of the world countries due to its ability to provide relief image elements with high tactile effect (portray, inscriptions, digital denomination, micro text).²⁶ The printing form was made from a precise drawing of fine lines. Among the most characteristic elements of the banknote are the serial numbers and signatures seen on the examined area, printed in letterpress by special numbering presses. It was observed and concluded that this is the first NB banknote that possesses the Guilloche pattern. Guilloche is a special technology used to protect banknotes, passports, certificates, stocks and other securities against forged copies. This kind of protection is based on covering the document by a complex composition of guilloche patterns which are thin decorative curves intersected numerously in an intricate way like textile lace.²⁷

23 The withdrawal from circulation began in July 1932. It lost its status of a legal tender on 18 July 1935.

24 Ж. Стојановић, *Папирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994. 98.

25 It is important to point out that the authors of the drawing and engraving were Alonzo Foringer and Robert Savage. Private correspondence with the historian Mark D. Tomasco on 17 June 2019, the author of the book *Images of value: the artwork behind US security engraving · 1830s–1980s*. New York, Grolier Club, 2017.

26 T. Kyrychok, P. Kyrychok, S. Havenko, E. Kibirkštis, V. Miliūnas, The influence of pressure during intaglio printing on banknotes durability, *Mechanika*, 2014 Volume 20(3): 327–331.

27 S. Usilin, D. Nikolaev, D. Sholomov, Guilloche elements recognition applied to passport page processing, *Conference: 8th Open German – Russian Workshop «Pattern Recognition and Image Understanding» Nizhny Novgorod, Russia 21 November 2011*.



Fig. 3

According to American banknote expert Franklin Noll, the procedures consisted of the following phases: “Once dry, the sheets would be overprinted or surface printed. Here the serial numbers and any seals or non-intaglio images would be applied. At this stage, the notes are complete but need to be separated into individual units. The printed sheets would have sizing applied to them and pressed to take out wrinkles. At this point, the notes would be cut apart or separated. They would then be packaged for shipment. During this entire process, the sheets would have been repeatedly counted and inspected for errors”.²⁸ Furthermore, in the period of KSCS, for the purposes of manufacturing another contingent of banknotes for circulation, the NBSCS continued to collaborate with *BdF*. It is important to point out that the *BdF*²⁹ has a long history of designing and printing banknotes, not just for France and the French community.³⁰ The preparation and production of the 100-dinar banknote, dated on 30 November 1920, took a long time, which caused that it was not released into circulation until 1 January 1925. The preparation of drawings and engravings, the procurement of paper and the printing process were all conducted by *BdF*. The author of the drawing, *Gustav Fraipont*, and the engraver,

²⁸ Private correspondence with banknote expert Franklin Noll on 31 Jul 2020.

²⁹ Nowadays, the *BdF* is the Euro system's largest manufacturer of banknotes, and has a leading player in the manufacture of euro banknotes.

³⁰ Banque de France designed and manufactured banknotes and coins for other countries such as Greece 1935 (Drachmas 50, 100, 1000), Montenegro-Royal Government of Petrovic 1914, 1 and 2 Perper, for Guadeloupe (1934–1943) 5 Francs, Madagascar (1937–47) 5, 10, 20 and 50 Francs, The Kingdom of Morocco 5 Francs 1924. New Caledonia Banque de l'Indochine (1926–1929, 5 and 20 francs) Mexico, Romania Banca Nationala a Romaine (1909–1920, 1, 2 and 500 Lei), Tahiti (5 francs 1927), Algeria, and Uruguay Peso in 1930. as well, as for Serbia from 1887–1935. See more: M. Daspre, *Trois siècles de billets français*, Hervas, 1989. 91–100.

Emile Deloche, both of whom did the obverse, and Rita who did the reverse, all came from *BdF*.³¹ It is important to point out that the obverse of the 100-dinar banknote dated 30 December 1920 signed with serial number X694 (Figure 3) is nearly identical to the obverse of the banknote dated 5 January 1905 (Figure 1). They were both made by *BdF*. Georges Duval, a French painter, drew the lady with ermine and the Belgrade panorama seen from the Sava River on the 1905 banknote (Fig 1). In this case the banknote of 100 dinars signed with the serial number X 694 carries the date 30 November 1920 (Figure 3) and has the signatures of Governor Đorđe Vajfert and a member of the Management Board Marko Stojanović. The Optical microscopy analysis on the first 100-dinar banknote signed with the serial number X694 (Figure 3) and the design of “Lady Heroine”, which is a personification of Motherland of KSCS, proved this banknote to be a typical example of use of *BdF* – French multicolor banknote, similar to the 100-dinar banknote issued in 1905, (Figure 1) but in this case the *BdF* used four plates of security inks for printing.³² The process of applying security ink layers is a combination of printing techniques that can be attributed to offset lithography which simulates 3-D effects. It was observed that the examined banknote has a combination of blue, violet and red security ink layers applied by involving offset lithography which creates images by using a line structure formation of vertical and diagonal lines. The printing form was made from a precise drawing of fine lines. As it is seen in the case of the 100-dinar banknote signed with the serial number B421 issued in 1905 (Figure 1), among the most characteristic elements of a banknote are the serial numbers and signatures seen on the examined area, and in this case they were also printed in letterpress by special numbering presses. The main difference on the obverse sides of these banknotes is in their watermarks – the older banknote issued in 1905, depicted the head of Mercury and in this case had the watermark depicting the head of Duke Miloš Obrenović.³³

Establishment of the Institute for Manufacturing Banknotes and Coins (ZIN) of NBKYU

Well known connections that were established between NB and *BdF* by the end of the 19th century were once more reinforced and strengthened when the construction of the Institute for Manufacturing Banknotes and Coins (ZIN) of the NBKYU had begun in 1927, based on the blueprints done by architect Joseph Naiman.³⁴ Institute ZIN’s general design was constructed according to the model of the French Institute in coordination with the Director of the Banque de France, Mr. F. Schuhler.³⁵ The construction was completed in October 1929. The Institute ZIN within the NB has over 90 years of experience in banknote production. The basic technology of banknote production, before World War II had four-color letterpress printing process, and for smaller banknotes offset printing was used. The printing process was partly inherited from the *BdF*. Initially “*Lamber*” printing

31 J. Хаџи Пешић, *Новац Србије 1868–1918*, Београд, 1995, 215.

32 M. Daspre, *Trois siècles de billets français*, Hervas 1989, p.98.

33 Due to its esthetics, this banknote is a favorite among numismatists worldwide. The new, fifteen years younger banknote features the same drawing of Belgrade and the woman with a robe lined in ermine, but the robe was enriched and fruit was added, while the image of a steamboat was modernized, and this was the first time that a distinguished person was depicted on the security feature on a watermark.

34 A. Kadijević, Arhitekt Josif Najman (1894–1951), *Moment 18*, Belgrade, 1990, 100–106.

35 ANB, 1/II, Governing Council, Minutes from the 1927.

machines were used for banknote printing within Institute ZIN.³⁶ According to the Archive data from the NBS, it was noted that the entire production depended exclusively on the French banknote production technology, which was incorporated into the Yugoslav printing Institute (ZIN). The technical agreement stated that materials, paper and security inks should continue to be procured from France. At the session of the Management Board of NB on April 15 1927, it was agreed that the printing machines of the Eduard Lamber and Marinon factories should be selected for the beginning of the establishment.³⁷

Printing techniques in the period of the Kingdom of Yugoslavia

The development of the artistic design for the 50-dinar banknote started in 1931 and was entrusted to Panta Stojićević and Veljko A. Kun.³⁸ The manager of the Institute for Manufacturing Banknotes, engineer Milivoje Obradović, produced a written report on this work for the General Manager of the NB.³⁹ To understand the design of this banknote, as well as the time when the work on it began and when the actual banknote was released into circulation, it is worth noting that although the drawing is dated 1 December 1931, it was manufactured and released into circulation only on 8 April 1941,⁴⁰ and at the time it was formed, in 1931, the visage of King Aleksandar I Karađorđević was suggested as the main motif on the obverse. Somewhat later, on 14 March 1931, the Governing Council of the National Bank decided to use the national coat of arms as the watermark, only to finally use the visage of Crown Prince Petar. Based on the decision of the Executive Committee of the NB of 9 September 1931, the order for the paper for this banknote with the watermark was submitted to the English company Portals Ltd. Hants.⁴¹ A decision had been made in February of the same year to entrust Đoka Jovanović with producing the watermark drawing. "Regarding the medallion for the filigree I propose the same should be assigned immediately to be produced by Mr. Đoka Jovanović, sculptor, so that prior to the definitive order of paper the same company could provide a test of the filigree on the quality of paper on offer, its quality intended to increase the security of the

36 Lj. Petrović, *Zavod za izradu novčanica i kovanog novca*, Narodna banka Jugoslavije: Zavod za izradu novčanica i kovanog novca, 1994, 19.

37 ANB, 1/II, Governing Council, Minutes from the 1927.

38 Veljko A. Kun (1877–1948) is the author of the first multi-colour banknote manufactured in our country. He was a xylographer, an artist working on woodcuts, particularly on producing woodcuts for multi-colour print. See more: Блануша, Мишела. *Ђорђе Андрејевић Кун: јоу пасарајн!*. Београд: Музеј савремене уметности, Галерија – легат Милице Зорић и Родољуба Чолаковића, 2016. 69–76.

39 Ј. Хаџи Пешић, *Новац Србије 1918–1941*, 1995, 161–162.

40 The release into circulation seven years after the assassination of King Aleksandar I, when the Kingdom of Yugoslavia was already under attack and at war. It was published in *Narodno Jedinstvo*, the official journal of the Royal Banovina Administration of the Drina Banovina, No 30 of 12 April 1941. (This information is stated in the monograph *Новчанице Народне банке 1884–2004*, provided to author Željko Stojanović by Toplica Marić, an official of the National Bank who researched the history of money issuance in Yugoslavia.)

41 In September 1931, the National Bank decided to order the paper for the printing of this banknote from the English company Portals (Portals Ltd., Hants, England). The first quantities of paper arrived at the Institute on 21 May 1932. The paper of this renowned English company was also delivered to the Institute for the production of other banknotes. See more: Ж. Стојановић, *Папирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994, 106–107.



Fig. 4

banknote”.⁴² In the same year in June, the stabilisation of the dinar⁴³ was enacted by the adoption of three important laws: the Law on Money of the Kingdom of Yugoslavia, the Agreement between the State and the NB for the Implementation of the Law on Money of the Kingdom of Yugoslavia⁴⁴, and the Law on the NB of the Kingdom of Yugoslavia (NBKYU) provided the need for manufacturing banknotes.⁴⁵ Furthermore, this banknote was made for the event of an emergency situation in the country, when silver coins disappear from circulation, to replace those coins, and to enable unhindered cash circulation. The size of the drawing on this multicolour banknote is 134 mm long and 78 mm wide. The watermark on the right side of the obverse and the left side of the reverse has a regular hexagonal shape 40 mm high, which features the head of King Petar II Karađorđević with a falcon feather hat. The text on the obverse of the banknote is given in Cyrillic, and on the reverse in the Latin script.

The Optical microscopy analysis on the 50-dinar banknote signed with the serial number Љ0617 (Figure 4) and the design with the visage of King Aleksandar I,

42 ANB 1/II, Governing Council, Minutes from the 79th GC session, 25. 2. 1931.

43 Period of de facto dinar stabilisation started with this new legal interpretation of Article 20 of the National Bank Law. The period lasted for entire six years, from August 1925 till 28 June 1931. See more: Foreign Exchange Policy in the Kingdom of Yugoslavia during and after the Great Depression. See more: D. Gnjatović, The Experience of Exchange Rate Regimes in Southeastern Europe in a Historical and Comparative Perspective *Second Conference of the South-Eastern European Monetary History Network (SEEMHN)*, Vienna, 13 April 2007.

44 The official name of the state was changed to “Kingdom of Yugoslavia” by King Alexander I on 3 October 1929.

45 By this law, for the first time since the establishment of the Kingdom of Serbs, Croats and Slovenes, in 1918, the dinar was designated as a monetary unit of the Kingdom of Yugoslavia. See more: S. Pantelić, Šta sve čini izuzetnom novčanicu od 1.000 dinara Narodne banke Kraljevine Jugoslavije *Bankarstvo*, 2019, vol. 48, br. 3 strana 70.

which is the symbol of continuity of the Karađorđević dynasty⁴⁶, proved this banknote to be a typical example of a combination of Yugoslav and BdF – French multicolor banknote, similar to the banknotes produced in the period of KSCS. It was observed that the examined banknote has a combination of dark security inks applied with a visible edge of the printed elements, by involving the letterpress printing technique, while the dry offset was used to apply yellow and blue security ink. The printing form was made from a precise drawing of fine lines. As it was seen in the previous cases of examined banknotes, the serial numbers and signatures seen on the examined area were also printed in letterpress by special numbering presses.

Printing techniques in the period of occupation of the Kingdom of Yugoslavia

The political and territorial partitioning of the Kingdom of Yugoslavia had already begun during the war. The top military and civilian authority in occupied Serbia after its capitulation on 17 April 1941 was held by a military commander on behalf of the German Reich. The General Plenipotentiary for the Economy in Serbia, in the broadest sense, was Marshal Hermann Goering. He later entrusted this post to his friend Neuhausen, who remained on duty until 1943.⁴⁷ The disbanding and appointment of the Serbian Government was under the competence of the military commander of the German Reich. The issues of operation and competence of the National Bank and the monetary system within the occupied Serbian territory were resolved through the principal decisions of the Reichsbank of 10 May 1941. Milan Nedić⁴⁸ was installed as Prime Minister during this period. Article 1 of the Order on the Serbian Monetary Bank placed the National Bank of the Kingdom of Yugoslavia under liquidation, while Article 2 declared the founding of the Serbian National Bank.⁴⁹ The occupying forces ran the economy in accordance with their interests. The Serbian National Bank, as the issuing institution for the occupied Serbian territory, was founded by the Decree of the General Plenipotentiary for the Economy of Serbia of 29 May 1941. Dr Milan Radosavljević, a pre-war Governor of the National Bank of the Kingdom of Yugoslavia, was appointed as governor, but all his decisions had to be confirmed by the German Commissioner to the Serbian National Bank, Jacobus Zengen, the advisor of the German National Bank. In the afternoon of 6 April 1941, on the day the German aviation bombarded Belgrade, the Bank's management set off for Užice. The director of the Reichsbank arrived in Belgrade on 29 April 1941 to

46 To the left, in a stylized oval, is the portrait of the King (1931), i.e. the Blessed Knightly King Aleksandar I (1941), turned face forward, with bare head and wearing a general's uniform, with both his epaulettes and the jacket showing the medal of Karađorđe's Star with Swords. The central part, between the two portraits, shows a landscape from the Boka Kotorska Bay, symbolically representing a landscape of the "Adriatic Guard", i.e. the Yugoslav coast and showing Aleksandar's achievement of unification – the creation of the state of Yugoslavia and the unification of Serbs, Croats and Slovenes into a single state.

47 М. Угричић, *Новац у Југославији за време Другој светској рати*, Београд, Југословенски преглед, 2000, 95.

48 Milan Nedić (1887–1946) was an army general, a retired minister and Prime Minister of the Serbian Government during the period 1941–1944.

49 The Serbian National Bank was not the legal successor to the National Bank of the Kingdom of Yugoslavia under liquidation. It was founded as a new issuing institution with operational jurisdiction over part of the pre-war Yugoslavia. See: М. Угричић, *Новац у Југославији за време Другој светској рати*. Београд, Југословенски преглед, 2000, 106.



Fig. 5

take up the post of the German commissioner at the National Bank.⁵⁰ After the April Blitzkrieg in 1941 and the German occupation, the National Bank of the Kingdom of Yugoslavia was liquidated and the Serbian National Bank was founded instead. The occupying German forces nationalized the Bank, along with all other important institutions. The Serbian National Bank was also liquidated in November 1944, upon the liberation of Belgrade from the occupying forces and the arrival of the new communist authorities. The plenipotentiary for economic affairs in Serbia, Franz Neuhausen, organized the entire economy to coordinate with the German four-year plan. Infrastructure, mining, and plants relevant for armament were placed under his supervision. Gold and securities from the vault of the Serbian national bank disappeared into the German treasury.⁵¹ The drawings for the 500-dinar banknote of graphic designer Miho Čakelja had a contemporary, attractive security design with elements of art deco. The manufactured banknotes were printed in a practical format, on two types of paper with different watermarks.⁵² The artistic designs, primarily regarding their color scheme, defy the greyness and hopelessness of occupation. The Designer Miho Čakelja placed an octagonal area for the watermark behind the back of the young woman, decorating it with a woodcut baroque relief pattern. The central segment holds the royal crown. The space in the background of the drawing for the 500-dinar banknote was decorated by the artist with a minimalist repeating

50 Ж. Стојановић, *Пайирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994. 78.

51 See more: M.J. Calic, *Geschichte Jugoslawiens im 20. Jahrhundert*, Verlag C.H.Beck oHG, München, 2014, pp. 142–143.

52 Ж. Стојановић, *Пайирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994, 117.

geometric pattern in a cold tonality. The banknote was issued on December 1, 1941 and withdrawn in 1945, after the liberation of the country. The Optical microscopy analysis on the 500-dinar banknote signed with the serial number Ж0063 (Figure 5) and the design with the main motif on Čakelja's design is the personification of the state – the mother-provider in the form of a young woman in the national costume with a scarf on her head, proved a typical example of Yugoslav security printing multicolor banknote manufactured within ZIN. It was observed that the examined banknote has a combination of applying dark security inks with a visible edge of the printing elements, by involving dry offset which was used to apply red, yellow, light blue and brown security ink. Furthermore, as it is seen in the previous cases on the examined banknotes, the serial numbers and signatures were also printed in letterpress by special numbering presses. At this point, we can conclude for sure that in the process of production of Serbian/Yugoslav dinar banknotes, the NB standard for production of banknotes abandons the procedures that were inherited from the *BdF*.

Printing techniques in the period of the Democratic Republic of Yugoslavia and the Federal Republic of Yugoslavia

During World War II (April 1941 – October 1944), the NB conducted its operations from its representative office in London. After World War II, the National Bank was nationalized. As of 15 January 1946, the central bank's name changed into the National Bank of the Federal People's Republic of Yugoslavia. In accordance with the economic circumstances during the occupation, the management of the Serbian National Bank reached a decision on the production of a full series of reserve banknotes on 27 March 1942, precisely one year after the protests against Yugoslavia's accession to the Tripartite Pact. Two years later, on 17 October 1944, when Nazi Germany was already losing the war, the occupying authorities emptied the treasury of the Bank's central office in Belgrade, the treasuries of its branch offices, as well as the treasury of the Institute for Manufacturing Banknotes. When Tito's⁵³ partisan anti-fascist movement and the Soviet Red Army liberated Belgrade, the occupying forces were expelled, and thus prevented from spending the money robbed from the Bank's treasury. The post-war authorities reached a decision on 4 November 1944 on placing the Serbian National Bank under liquidation.⁵⁴ Near the end of World War II, in 1944 and early 1945, the National Bank of the Kingdom of Yugoslavia owned buildings only in towns that had been liberated. Based on the model of the Soviet Union, when World War II was over in the country, a single-party, communist, national, social and economic order was introduced. Personnel changes were effected within the managerial structure of the National Bank in early February 1945, dismissing the NB officials in exile.⁵⁵ Several days after the appointment of Governor Tanasije Zdravković, the Governing Council of the NB of the Kingdom of Yugoslavia, decided at the session held on 6 December 1945, to propose changes to the legislative authorities and change the name of the Bank, from then on to be called the National Bank of the Federal People's Republic of Yugoslavia. The first series of eight banknotes, issued after World War II, shows a Partisan soldier with the rifle over the shoulder on the obverse and the coat of arms and the year of issue, 1944, on the reverse. The size of the banknote is 110x56mm.

⁵³ Josip Broz Tito.

⁵⁴ Ж. Стојановић, *Пайирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994, 111.

⁵⁵ Ј. Хаџи-Пешић, *Новац Србије од 1941–1992*, 1995, 14.



Fig. 6

The Optical microscopy analysis on the 50'dinar banknote signed with the serial number ГВ 179427 (Figure 6) and the design with the main motif of a Partisan soldier designed by Đorđe Andrejević Kun represents the typical example of a USSR Goznak two-color banknote design.⁵⁶ It was observed that the examined banknote has a combination of violet security ink applied by involving letterpress printing technique and grey under print, also in the case of ornamented paper, which is specific for the USSR Goznak manufacturing banknotes. Furthermore, as it is seen in the previous cases on the examined *BdF* and Yugoslav processes of printing banknotes, the serial numbers and signatures were also printed in letterpress by special numbering presses.

As it was mentioned, on 15 of January 1946, the Bank's name changed into the NB of the Federal People's Republic of Yugoslavia, and then in 1963 into the NB of Yugoslavia. The NB of Yugoslavia Law, 1965 determined the Bank's powers and responsibilities in detail. The Bank is responsible to the Federal Assembly and to the Federal Executive Council; as a general principle, it is independent in the performance of its tasks, but for certain key policy instruments the NB Law keeps the final decision under the jurisdiction of the Federal Executive Council. The National

⁵⁶ Г. Яукович, Сотрудничество Национального банка с Предприятием по производству денежных знаков «Гознак» НКФ СССР на подготовке и печати банкнот в период после II мировой войны 1944–1947. 2019. 274–280. Вторая международная конференция Деньги в российской истории: вопросы производства, обращения, бытования, Деньги в российской истории вопросы производства, обращения, бытования Санкт-Петербург, 16–18 октября 2019 года.

Bank's operations are supervised by the Federal Secretariat for Finance.⁵⁷ It is worth mentioning that the paper needed by Institute ZIN used to be acquired abroad before the war. After WWII, acquisitions continued until 1948 when, due to the extremely difficult situation in terms of providing the foreign exchange, a decision was made to produce in the country the paper needed for banknotes. A year later, in 1949, the first domestic paper for the manufacture of banknotes was obtained, which was of quite satisfactory quality in the then prevailing circumstances. At the beginning of the fifties, as a part of an attempt to adopt the latest technology in banknotes printing, Institute ZIN decided to purchase new "De la Rue Giori" printing machines. Thus, in 1953, two "De la Rue Giori" relief printing machines were purchased. They were three-color two-plate machines, with trichloroethylene drum-cleansing. After the disintegration of the Socialist Federal Republic of Yugoslavia, the only factory – producer of the highest quality paper remained in Slovenia, so that the needs of the Works were being again covered by imported paper. Under the 1963 Constitution, the name of the state was changed into the Socialist Federal Republic of Yugoslavia (SFRY). On that occasion the NBYU issued a new series of banknotes dated May 1, 1963, and put them in circulation on 15 September 1964.⁵⁸ The following motif was used, with the emphasis on the economic development of the country: on the obverse side of the 5000'dinar banknote (Figure 7) is a part of the relief of the "Kosovo girl" sculpted by Ivan Meštrović in 1909, and based on those blueprints⁵⁹ the banknote was designed by Miodrag Petrović. The Optical microscopy analysis on the 5000-dinar banknote signed with the serial number AM268424 and the design of the vignette "wounded soldier and the girl of Kosovo", which represented a symbol of compassion, released in 1964 by the NBYU, proved this banknote to be a typical example of use of the Yugoslav style multicolor banknote. This banknote does not have a watermark. The process of applying three security ink layers involved the printing technique that can be attributed to line intaglio printing which simulates 3-D effects. It was observed that the examined banknote has a combination of dark blue, light blue and yellow security inks applied. The printing form was made from a precise drawing of fine lines, but it was not done manually. The serial numbers and signatures were also printed in letterpress by special numbering presses. Further introducing new technologies, Institute ZIN bought the most advanced banknote-printing machines in 1973. It was the "Intagliocolor 8", a four-plate three-color machine.⁶⁰ Also it is important to point out that until 1956 xylography was used. At the time, the Art Studio was equipped with "Kämpf" and "Naderni" guilloche machines of the mechanical type. Introducing new technologies, the Institute opted for relief-printing. The already mastered xylography technique greatly alleviated the transition towards the copper-plate engraving technology. During the seventies, the following changes in Yugoslav paper money production took place in 1970/71: the "Simultan" five-color tone printing machine and the "Numerota" numbering machine were purchased in 1970. The capacities producing the paper needed for the banknotes were provided (from

57 J. J. Hauvonen, "Postwar Developments in Money and Banking in Yugoslavia" *Staff Papers (International Monetary Fund)*, vol. 17, no. 3, 1970, pp. 563–601. JSTOR, www.jstor.org/stable/3866359. 05/05/2021.

58 Denominations of this series have the aspects identical to the third series of NB of FNRY, See more: Ж. Стојановић, Папирни новац Србије и Југославије, 1929–1994., Народна банка Југославије 1994. 144.

59 *Engraving for the banknote was done by Božidar Kocmut.*

60 Lj. Petrović, *Zavod za izradu novčanica i kovanog novca*, Narodna banka Jugoslavije, Zavod za izradu novčanica i kovanog novca, 1994, 19.



Fig. 7

1974 to 1985 with impressed thread, and since 1985 with the watermark), together with the paper for other securities. Earlier, the 500-dinar banknote (Figure 7), date of issue 1 August 1970, with the drawing of a detail of the “Nikola Tesla” sculpture designed by Miodrag Petrović and Bojana Spremo based on the sculpture done by Frano Krsinić in 1956, was very popular in the United States and was sold with the large agio above nominal value. The Optical microscopy analysis on the 500-dinar banknote signed with the serial number DV495478 and the design of the “Nikola Tesla” vignette, which represented a symbol of Yugoslav contribution to the science, released in 1970/71 by the NBYU, proved this banknote to be a typical example of use of Yugoslav-style multicolor banknote. This banknote does not have a watermark. The process of applying three security ink layers involved a printing technique that can be attributed to line intaglio printing which simulates 3-D effects. It was observed that the examined banknote has a combination of dark blue, yellow and light blue security inks applied. The printing form was made from a precise drawing of fine lines, but it was not done manually. The serial numbers and signatures were also printed in letterpress by special numbering presses. In literature it is stated that this



Fig. 8

banknote has a security thread and fluorescent fibers in red and blue fibers, which are visible under UV light. Therefore, it could be concluded, that this was the first banknote, which had an incorporated invisible security feature.⁶¹

In the 1990, the Art Studio produces complete designs that are transformed into tools for line and relief offset printing with the aid of computer graphics and original hand-engraving done by a skilled artist.⁶² The new banknotes, with the

61 Ж. Стојановић, *Пайрни новац, Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994, 193.

62 Lj. Petrović, *Zavod za izradu novčanica i kovanog novca*, Narodna banka Jugoslavije, Zavod za izradu novčanica i kovanog novca, 1994, 18.

year of issue 1991, had the largest denomination of 5000 dinars, in addition to the successful graphic solution, technically improved, because the security thread woven in the paper was from silver foil, thus making it impossible to counterfeit at that time. The Optical microscopy analysis on the 5000-dinar banknote signed with the serial number AA 288603 (Fig 8) and the design of the portrait of Ivo Andrić, distinguished writer, which represented a symbol of a Nobel-Prize winner, released in 1991 by the NBYU, proved this banknote to be a typical example of the use of Yugoslav-style multicolor banknote. This banknote has a watermark depicting also the portrait of Ivo Andrić. It was observed that the examined banknote was printed using a combination of printing techniques: the line intaglio printing technique – a combination of manual and machine engraving, and the offset lithography. The process of applying three security ink layers involved a printing technique that can be attributed to line intaglio printing which simulates 3-D effects. It was observed that the examined banknote has a combination of violet and red-orange security inks applied. The printing form was made from a precise drawing of fine lines, and it was done by machine. The serial numbers and signatures were also printed in letterpress by special numbering presses. In literature it is stated that this banknote has a security thread and fluorescent fibers in red and blue fibers, which are visible under UV light. Furthermore, on 24 January, 1994, there was the decisive “surgical” monetary intervention made by Dragoslav Avramović, who created the Monetary Reconstruction Program, and thereby played an extremely important role in eliminating hyperinflation in January 1994, which caused the issuance of new series of banknotes. In the case of the last banknote of 50 new dinars signed with the serial number AF 7299776 (Fig 8) and the design of the portrait of Duke Miloš Obrenović, issued in 1996, the Optical Microscopy analysis proved this banknote to be a typical example of the use of Yugoslav-style multicolor banknote. This banknote has a watermark depicting continuous rhomboids. It was observed that the examined banknote has a combination of printing techniques applied by involving the line intaglio printing technique – a combination of manual and machine engraving, and also a letterset printing technique and dry offset. The process of applying three security ink layers involved the printing technique that can be attributed to the line intaglio printing, which simulates 3-D effects. It was observed that the examined banknote has a combination of violet, light blue and red security inks applied with fluorescent fibers, and that it contains geometric forms over the entire paper. The printing form was made from a precise drawing of fine lines, but it was done manually and with a machine. The serial numbers and signatures were also printed in letterpress by special numbering presses. In literature it is stated that these banknotes have a security thread and fluorescent fibers in red and blue fibers, which are visible under UV light and with micro text incorporated. Drawing was done by Dragiša Andrić, engraving by Dušan Matić and Dragana Petrović and the computer graphic was done by Srećko Hlasni and Tomislav Perić.⁶³

CONCLUSION

Despite its primary objective and responsibilities to maintain and strengthen the stability of the financial system, the National Bank has also been a sole issuer of Serbian banknotes and coins for the past 136 years. Understandably, one of the

63 Ж. Стојановић, *Пайирни новац Србије и Југославије, 1929–1994.*, Народна банка Југославије 1994. 251.

priorities of the Bank is to manufacture, design, and implement the security features and security printing techniques for issuing banknotes and coins for the payment system in the country.

Manufacturing and issuing of banknotes was of great importance during preparations for the initial phase of regular operations of the Privileged National Bank of the Kingdom of Serbia. The shaping of security designs for the Bank's banknotes was conditioned primarily by the matrices created by the National Bank in cooperation with the Banque de France. Finally, with contemporary needs that relate the Bank's needs to designs produced by renowned artists-associates, cooperation was established between the Bank's adviser and sculptor Đorđe Đoka Jovanović and artists-associates such as Georges Duval and Ernest Florian. Active cooperation was immediately initiated with fine and applied artists and scientist working on the production of conceptual and applicable security designs for the Bank's banknotes. As a result of this investigation, the following conclusions can be drawn and observed chronologically.

During the examined period from 1905 to 1996, the Bank underwent a number of transformations caused by national political and social changes; therefore all of those circumstances influenced the process of security design and applying security ink layers, security features and the usage of a combination of printing techniques. In the period of the Kingdom of Serbia, as it was observed on the 100 dinar banknote signed with the serial number B421 issued in 1905, the process of applying security ink layers had a combination of printing techniques that can be attributed to offset lithography – a typical example of use of Banque de France – French two color banknote, and the signatures and serial numbers that were applied were printed in letterpress by special numbering presses. As for the security feature, the banknote possessed a watermark depicting mythological portraits of Greek and Roman Gods.

After World War I and the unification of part of the South Slavs, the National Bank of the Kingdom of Serbs, Croats and Slovenes was established, as the legal successor of the PNBKS (1920 –1929) and took over the operations across the entire territory of the kingdom under this name. During the period of the Kingdom of Serbs, Croats and Slovenes, the National Bank cooperated with the most renowned Institutes for manufacturing banknotes in Europe and America. It was determined that during the cooperation with the American banknote Company, there was the first National Bank's 10-dinar banknote signed, with the serial number AK 839986, which was manufactured by combining the intaglio printing technique with the application of a Guilloche pattern as a security feature. Also, for the application of other ink layers, offset lithography was used, and this banknote did not possess the watermark. The designs were produced by renowned artists-associates Alonzo Foringer and Robert Savage, both employed in the American banknote Company. While in the same period of the Kingdom of Serbs, Croats and Slovenes, in the case of the 100-dinar banknote signed with the serial number X694, and manufactured within the Banque de France, the technological process of security printing was nearly identical to the first observed banknote dated from the 1905, but in this case of the 100-dinar note, the Banque de France used four plates of security inks for printing. Therefore, the usage of a printing technique that can be attributed to offset lithography which simulates 3-d effects was determined. The main difference on the obverse sides of these banknotes from 1905 and 1925 is in their watermarks – the older 100-dinar banknote issued in 1905 depicted the head of Mercury and

in the case of the 100-dinar banknote from 1925 it was determined that this was the first time that a distinguished person, i.e. the head of Duke Miloš Obrenović was incorporated in the form of a watermark. The security design was produced by Gustav Fraipont and Emile Deloche, both employed within the Artistic studio of Banque de France.

Following certain historical moments, and the countries' transformation into the Kingdom of Yugoslavia, the Institute for manufacturing banknotes – ZIN was established. Besides, there was insistence on placing emphasis on political propaganda in the visual message of the banknote – during the 1930s the emphasis was on the portraits of Aleksandar I Karađorđević and other members of the dynasty. On the analyzed banknote of 50 dinars signed with the serial number Љ0617, a combination of the usage of Yugoslav and Banque de France – French multicolor banknote was determined, similar to the banknotes produced in the period of the Kingdom of Serbs, Croats and Slovenes. In this case, the creation of the precise drawing of fine lines of the 50-dinar banknote involved the application of the letterpress printing technique and dry offset, which was not the case in the period of the Kingdom of Serbs, Croats and Slovenes. The development of the security design for the 50-dinar banknote was entrusted to Panta Stojićević and Veljko A. Kun, both employed in the artistic studio of the Institute for manufacturing banknotes and Coins – ZIN.

During the occupation, there was not only the insistence on national symbols, but also on the symbols of wealth, which was clearly part of the propaganda machinery of the occupying authorities, since Serbia was far from wealthy at the time. It was determined in the case of the occupation 500-dinar banknote signed with the serial number Ж0063 that it is a typical example of Yugoslav security printing multicolor banknote manufactured within ZIN. It involved the dry offset printing technique and the letterpress. By observing, it was concluded that this was the main point when the process of production of Serbian/Yugoslav dinar banknotes abandons the procedures that were inherited from the Banque de France. The security design for this banknote was created by graphic designer Miho Čakelja, who offered the most contemporary Art deco design within the competition for the banknotes for the Serbian Bank.

Following World War II, a specific political-dogmatic, memorial, didactic and propagandist visual system was established by the new communist authorities after 1944/45. This was reflected in the concept designs produced between 1945 and 1946, indicating a trend that would develop during the coming years, based on erasing the visual designations of the previous (defeated) regime and the creation of a new iconography that was fully in line with the goals of the new authorities. These earliest security designs provide a glimpse of the socialist-realism genre of the people's struggle for liberation, with unequivocal insistence and reminders of the anti-fascist and liberating role of Yugoslav Partisans. On the observed banknote of 50 dinars signed with the serial number ГВ 179427, created by Đorđe Andrejević Kun, it was determined that it represents a typical example of a USSR Goznak two-color banknote design. The process of production of the analyzed banknote involved the letterset printing technique and the usage of ornamented paper, a specific kind for the USSR Goznak manufacturing banknote security process. In addition to the importance of harmonizing the security features and graphic design standards for the manufacturing of banknotes with the European standards of the time, the security designs for banknotes of the National Bank also

displayed a multi-layered nature in both meaning and the visual and security form regarding different security printing techniques during the preceding lengthy period, until around 1945, when the sophisticated symbolic, multi-layered visual vocabulary was lost in the singular and universally understandable representations of the new regime.

Regarding the transformation, the Bank's name changed into the National Bank of the Federal People's Republic of Yugoslavia, and then in 1963 into the National Bank of Yugoslavia. On the investigated banknote of 5000 dinars signed with the serial number AM268424 and the 500-dinar banknote signed with the serial number DV495478, both proved to be a typical example of the use of a Yugoslav style multicolor banknote. The usage of line intaglio printing which simulates 3-d effects was determined, and the printing form for the drawings was done by the machine; also in both cases the banknotes did not have a watermark. On the other hand, on the 500-dinar banknote signed with the serial number DV495478, it was determined that this is the first banknote with incorporated invisible security features – fluorescent fibers in red and blue fibers, which are visible under UV light. The security designs were created by Miodrag Petrović and Bojana Spremo, both employed at the Institute for manufacturing banknotes and coins – ZIN.

As for the following period, after the monetary reconstruction and introduction of the new dinar, it was determined that the banknotes had a combination of the applied printing techniques by involving the line intaglio printing technique – a combination of manual and machine engraving, also a letterpress printing technique and dry offset. Furthermore, what was noticed was the incorporation of a silver thread with microtext and the involvement of invisible security features such as fluorescent fibers in red and blue, which are visible under UV light. Representation of the distinguished persons from Serbian history was used with the emphasis on the economic development of the country. However, the multi-layered nature of the meaning made it possible, just like in fine arts in general, for everyone to understand and recognize, in part or fully, and in accordance with their level of knowledge, certain visual representations or messages on banknotes, as well as to ensure mass communication of these visual messages, meanings and symbols, thus making them part of everyday visual culture of the population.

ILLUSTRATIONS

- 1: Examination of printing techniques on 100-dinar, B421 banknote of PNBKS, issued by BdF in 1905, by Optical microscope Olympus CX41 (Magnification: 50 x)
Испитивање технике штампања на новчаници од 100 динара, Б421 ПНБКС, издате од БДФ 1905. године, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 x)
- 2: Examination of printing techniques on 10-dinar banknote, AK 839986, issued in ABCo in 1919/20, by Optical microscope Olympus CX41 (Magnification: 50 x)
Испитивање технике штампања на новчаници од 10 динара, АК 839986, издатој у АБЦо 1919/20. године, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 x)
- 3: Examination of printing techniques on 100-dinar banknote, X 694 from 1925/29, by Optical microscope Olympus CX41 (Magnification: 50 x)
Испитивање технике штампања на новчаници од 100 динара, Кс 694 из 1925/29. године, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 x)
- 4: Examination of printing techniques on 50-dinar banknote, signed with serial number Љ 0617, by Optical microscope Olympus CX41 (Magnification: 50 x)
Испитивање технике штампе на новчаници од 50 динара, потписаној серијским бројем Љ 0617, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 x)
- 5: Examination of printing techniques on 500-dinar banknote, signed with serial number Ж0063, by Optical microscope Olympus CX41 (Magnification: 50 x)
Испитивање технике штампе на новчаници од 500 динара, потписаној серијским бројем Ж0063, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 x)

6: Examination of printing techniques on 50-dinar banknote, signed with serial number GB 179427, by Optical microscope Olympus CX41 (Magnification: 50 ×)
 Испитивање технике штампе на новчаници од 50 динара, потписаној серијским бројем GB 179427, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 ×)

7: Examination of printing techniques on 5000-dinar banknote, signed with serial number AM268424 and 500-dinar banknote, signed with serial number DV495478, by Optical microscope Olympus CX41 (Magnification: 50 ×)
 AM268424 и новчаница од 500 динара, потписане серијским бројем ДВ495478, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 ×)

8: Examination of printing techniques on 5000-dinar banknote, signed with serial number AA 288603 and 50-dinar banknote, signed with serial number AF 7299776, by Optical microscope Olympus CX41 (Magnification: 50 ×)
 Испитивање технике штампе на новчаници од 5000 динара, потписаној серијским бројем AA 288603 и новчаници од 50 динара, потписаној серијским бројем АФ 7299776, оптичким микроскопом Олимпус ЦКС41 (увећање: 50 ×)

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SOURCES

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АНБ, 1/II, Управни одбор, Записник са. ANB, 1/II, Governing Council, Minutes from the year 1927

ANB 1/II, Governing Council, Minutes from the 79th GC session, 25/2/1931

ABBREVIATIONS

Archive of the National Bank of Serbia (ANBS)

National Bank of the Kingdom of Serbs, Croats and Slovenes, (NBKSCS)

National Bank of the Kingdom of Yugoslavia (NBKYU)

National Bank (NB)

National Bank of Serbia (NBS)

Banque de France (BdF)

Гордана М. ЈАУКОВИЋ, Предраг М. ЖИВКОВИЋ
МИКРОСКОПСКО ИСПИТИВАЊЕ СИГУРНОСНЕ ТЕХНИКЕ ШТАМПАЊА НА ИСТОРИЈСКИМ НОВЧАНИЦАМА – Студија случаја: Новчанице српског динара издате у периоду од 1905. до 1996.

Резиме: У овом раду се објашњавају карактеристике у процесу дизајнирања, израде и заштите новчаница од фалсификовања које је Народна банка емитовала у периоду од 1905. до 1996. Комплексна монетарна историја Народне банке током XX века, у периоду од 1905. до 1944. године, уочи оснивања Завода за израду новчаница – ЗИН, условила је производњу новчаница у различитим штампаријама у Европи и Сједињеним Америчким Државама. Испитивање десет новчаница начињено је микроскопом Олимпус Ц-икс41 (Olympus CX41), на који је постављена дигитална камера УЦ30 (UC30). За аквизицију слике коришћен је софтвер Цел-А, верзија 3.1 (Cell Av3.1). Као извор светлости коришћена је лампа са оптичким каблом и усмереним снопом беле светлости, која је падала на површину снимања под малим углом. Снимано је са увећањем од 50 пута. За сваки анализирани примерак новчанице, разматрано је неколико различитих карактеристика новчаница (водени жиг, серијски број и технике сигурносног штампања на 6 до 10 тачака). Разлике су откривене у процесу сигурносне штампе кроз државне и монетарне трансформације у периоду од 1920. до 1944. Методолошка сложеност овог истраживања намеће потребу за развојем састављања базе података са архивским документима о издавању, производњи, графичком дизајну и техникама сигурносне штампе која се користила за производњу новчаница Народне банке. Добијени резултати, путем коришћења оптичког микроскопа нам дају могућност да се утврде блиске вредности и сличности у области сигурносне штампе и заштите новчаница од фалсификовања унутар монетарних унија у источној и централној Европи, а посебно у Републици Србији.

Кључне речи: безбедносна штампа, заштитни елементи, новчанице, српски динар, нумизматика, Народна банка, оптичка микроскопија