# *Don't* copy that: Security printing and the making of high-tech paper

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**Abstract**
Printing is not a new media technology, but it is continuously being renewed. In this sense, it is an example of novelty going largely unnoticed, woven into the quotidian and ordinary in unassuming ways. One reason for this is the incomplete way we tell the story of printed paper, which privileges narratives of readings, access, and dissemination. To complicate the way media scholars think printing, this article turns to the case of security printing, which produces objects like banknotes and passports that circulate with trust and authority. Here, printing emerges through the specific need to print securely, offering a narrative based on the need for order and protection. The work of security printing, always straddling between art and science, produces artefacts understood as authentic copies. Such a transformation of paper into valuable object relies on the technical artistry of the security printer, who sets the aesthetic and material standards of authenticity through physical features like watermarks, engravings, holographs, special substrates, threads, or inks. Drawing on a close reading of informational materials produced by the major actors of today's security printing industry, this article explains how the need to print better than the (counterfeiting) competition fuels the need for novelty in the how of printing. It expands on three guiding principles that work in unison to keep printing on paper new: printing as material science, as complex composition, and as the display of matchless quality. Ultimately, this material quality of securely printed papers helps us think about the new in a way that is not tied up to the digital, so that security printing both complicates the way media scholars engage with printing and offers a reconsideration of the ways we categorize and theorize the differences between media 'old' and 'new'.

**Keywords**
Authenticity, banknotes, materiality, media history, passports, printing, reproduction, security printing

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Just what is real?

## Introduction: Renewing printing with secure papers

Printing is not a new media technology, but it is continuously being renewed. In this sense, it is an example of novelty going largely unnoticed, woven into the quotidian and ordinary in unassuming ways. One reason for this is the incomplete way we tell the story of printed paper. Indeed, printing often appears in conventional tellings of media history through Gutenberg's printing press, a moment when printing was already merging with a particular artefact, the mechanically printed book. Printing then becomes synonymous with 'printing press', charting the course for a story of reading, dissemination, and accessibility at the dawn of mass literacy. It is a terminological overlap that leads to imprecision, as for instance apparent when Victor Hugo writes in 1831 that – depending on how *imprimerie* is translated – either the invention of printing *or* the printing press is 'the greatest event in history' and 'the mother of revolutions' (2016: Book 5, Ch. 2).[1] This narrative of printing, as that which opens the floodgates of knowledge to a wider public, has become the standard way of thinking the activities and artefacts of printing in media studies. But this limited perspective is partly to blame for what Lisa Gitelman has described as the 'poverty of terminology' that makes it difficult for media scholars to talk about 'printing' or 'print culture' 'with any great precision' (2014: 8). To talk about printing thus remains 'tricky' and 'problematic' (2014: 8) in part because we have continued to use a singular term to speak about centuries-worth of technical activity.

There are indeed other printing stories to be told. This article explores one of them, a printing that emerges not through the prism of reading but from the specific need to print *securely*. Secure papers are those that are recognized and that circulate as genuine, official, and legitimate. Through the technical artistry of the printer, papers become transformed into 'unique pieces of artwork' that 'blend aesthetics, science and security', thus becoming valuable, functional, and trustworthy (De La Rue, 2018a). Examples like banknotes and passports are layered and complex, mobilizing the senses through feel and textures, intricate graphical marks and images, and an assortment of optical tricks and illusions. While artefacts like printed books regularly appear in debates on the meanings and futures of so-called old or even obsolete media (Coit Murphy, 2003; Nunberg, 1993), security printing rather operates in a complex and innovative technological playing field, even though it is also printed paper.[2] This ingenuity is a response to the particular challenges of producing secure papers: they must be unique but also numerous; identical to one another but also clearly distinguishable from counterfeits; easy to recognize but difficult to replicate. How do the printers do it?

The answer lies with security printing, a specialized industry devoted to the production of all manner of official and authentic papers. Alongside banknotes and identity documents – which are the examples used here – security printing is also responsible for items like tax stamps, certificates of authentication, vouchers, birth and death certifications, and brand protection labels.[3] As an industry, it includes the collection of technologies, processes, organizations, and infrastructures concerned with marking things as 'real' to 'secure currencies, protect identities, revenues and brands' (De La Rue, 2018a). The main challenge for security printers is counterfeiting, a constant threat that assures a perpetual renewal of printing through scientific research in fields like

chemistry and physics that develop new and better materials, techniques, and processes to guarantee the integrity and authority of securely printed papers.

While secure papers are part of the everyday, security printing has for many reasons largely failed to capture the public imagination. For one, though printing continues to be ever present in the world of things that surround us, its story is often stuck in the past: major improvements to printing technologies after the mechanical press and metal type were slow and steady with better paper, better inks, and better machines, all part of a gradual rather than spectacular process of perfecting the 'revolutionary' technology of printing (Eisenstein, 2005).[4] Once printing gave way to the electronic and digital 'ages', it became a marker of the passage of time, carrying that particular burden of being ubiquitous and invisible, a lingering remnant rather than an exciting portal into the future. Second, the problems of counterfeiting and forgery to which security printing responds don't generally garner much immediate sympathy or fear, so that the ways we curtail these transgressions have remained marginal to media history. Finally, the effectiveness of the security printing industry depends on an ability to stay technologically ahead of the curve, to work in the shadows and in control of the kind of attention it draws to itself. This logic of protectionism means we know surprisingly little about where our money and passports come from. It has also meant that research on printing – whether material and technical, conceptual and theoretical – has engaged very little with security printing, creating a blind spot in understandings of what printing is and has become.

Security printing is an industry with many actors: the customers (governments, national banks, commercial organizations), the printers themselves along with their networks of suppliers, and the governing bodies that establish standards. The objective here is not to examine each of these separately, but rather to present the industry holistically in order to consider how it contributes to the continuous renewal and expansion of printing. And while security printing is an umbrella term that refers to the entire industry – and that is how it is used here – within the industry itself there are distinctions made between the various stages in the production of official papers, with *printing* referring to the production of graphical marks. The design of these 'print elements' is differentiated from the design of the substrate, or of other security features (e.g. holographs), but all of these still constitute the activities of 'security printing'. Thinking across these two meanings is an example of how printing is stretched as a term, and how the abundance of techniques and features that are required to produce a securely 'printed' object helps to expose the high-tech and multimedia nature of today's printing.[5] This ambiguity about what exactly constitutes 'security printing' is an excellent example of Gitelman's (2014) point that 'the term "print" has floated free of any specific technology' (p. 7), with a 'variety of production and reproduction techniques . . . generalizable somehow as "printing"' (p. ix).

The need to print securely changes, adds to, and problematizes what and how media scholars think (about) printing, as technology and practice. On the one hand, the arrival of printing is rightly considered a pivotal moment in media history that made accessible mechanical reproducibility. On the other, the need for security offers an altered script, one where printers would strive to materialize trust and authority in paper by controlling and containing reproduction. The goal in this article is to explore this paradoxical situation, starting by considering how security printing offers a distinct narrative of printing that helps us think about the new in a way that is not tied up to the digital. Then, it turns to a close reading of informational materials produced by today's security printing industry[6] to distill three of its guiding principles, which work in unison to keep printing on paper new. First, it is a printing that works in the realm of material science, stressing the functional role of innovative materials. Second, it relies on complex composition, which protects the

relationship between the original matrix – as a collection of materials, techniques, and processes – and the printed copy. Third, security printing is a kind of reproduction that privileges unmatched quality and skill, with this need to print *better than* the (counterfeiting) competition also fueling the need for novelty in the *how* of printing. Ultimately, through the lens and artefacts of security printing, the aim is to both complicate the way media scholars engage with printing, and to, in a broader sense, offer a reconsideration of the ways we categorize and theorize the differences between media 'old' and 'new'.

## Through the lens of security: A distinct narrative of printing

Printing is too varied to be either old or new or even either digital or analog. In general terms, it is understood as the act of inscribing or marking a surface through reproducible means. It includes a wide range of practices and technologies performed by a human or a machine: the printer. As a research topic printing does not belong to any one discipline, but it is worth remarking on some of the fields that have had a particular influence in defining the focal objects through which we have come to trace the material and social history of printing. For example, the emphasis on information, knowledge, and access that comes through the story of Gutenberg's printing press and of printing as an engine of the European Renaissance helps explain the weight given to printed materials meant for reading, such as pamphlets, periodicals, newspapers, and especially books. Noted print historian Michael Twyman observes that 'printing historians have focused on the book', so much so as to consider that 'print culture and book culture amount to much the same thing' (2008: 20), a position he and others challenge by turning to printed ephemera, or the 'minor transient documents of everyday life' (Ephemera Society in Britain via Twyman, 2008: 19). Printed ephemera are the 'cheap and necessary' pieces of paper of quotidian life: 'advertisements . . . almanacs, licences, price lists, tickets, printed forms, political squibs, slip songs . . . and cheap religious images' (McKitterick, 2018: 22). It is a small area of research for historians of the book, but it has also interested a variety of collectors, archivists, and scholars, including in art history (Roberts, 2016; Taws, 2013) and media studies (Adams, 2007; Gitelman, 2014; Krajewski, 2011). However, printed ephemera is an awkward category for those bits of paper that, as is argued here, are not quite 'minor' or 'cheap', such as banknotes or passports.[7] At the very least, secure papers cannot be understood only or even primarily through their everyday use because so much of what makes them noticeable and meaningful is their value and technical sophistication. Moreover, many historians, through a variety of objects, have contributed to a technical history of printing, including book historians (McKitterick, 2018; Pittion, 2003) and art historians (Benson, 2008; Dyson, 1984; Griffiths, 2016; Ivins, 1969; Robins Pennell, 1898). To think about security printing is to draw on and continue this work, writing a material history that privileges secure papers as the lens through which to think printing, not only as existing in relation to books, ephemera, or artworks but as significant artefacts in their own right.

The emphasis on reading has solidified the media history of printing as told through a narrative of access. Narratives are important because they shape how technologies are imagined, used, and represented, and they help us 'make sense' of the ways the socio-technical becomes crystallized (Natale, 2016).[8] The first print run of reading material, in Japan in 770 (Kornicki, 2012),[9] already announced printing as a technology of large-scale dissemination. Much later, Gutenberg's work in the 1440s on reusable moulds would set the stage not only for standardized uniformity but also for a history of printing told through and as the growth of literacy. Making this possible was the accessibility of the printing technologies themselves, so that both to read (content) and to print

(tools) become with time increasingly within reach. A narrative of access threads through textual and visual reproductive technologies,[10] and with it emerge questions on the authenticity, originality, and status of the printed copy (Benjamin, 2007; Griffiths, 2016; Robins Pennell, 1898).

Security printing proposes a different narrative, a different way to 'make sense', one in which the story of printing develops through a need for order, protection, and security, rather than access, and where the action is centered specifically on the (re)production of original and authentic copies. Indeed, this is the crux of the problem to which security printers must respond: differentiating copies from one another and distinguishing papers as products of certain (legitimate) makers and producers. There are examples of distinctive signs marking – 'securing' – documents since at least the Middle Ages: seals, signatures, watermarks, and insignia are all part of the visual material apparatus of authentication and identification that makes certain papers distinguishable and valuable. But it is the shift from coins to paper banknotes starting in the late 17th century that propels the development of a security printing industry. The shift away from using precious metals in the production of money – or a 'metalist idea of money' (Shin, 2015: 417) – meant that it became essential to convey not only that 'flimsy'[11] pieces of paper were legitimate and authoritative but also to convince the public that these papers were not easy to make/print, and thus could not be counterfeit. Printing securely required the right materials, tools, techniques, and know-how, as well as the authorization to print, paving the way for a specialized industry in which printing was to be the reproduction of a particular sensory experience, and not just of visual or textual information. An enterprise with the mission to transform paper with little intrinsic value into something valuable, security printing would articulate the link between social use and material form through a protected kind of printing. If counterfeiting was considered as a threat to the real (Groom, 2001: 13), then security printing was to be the guardian of the authentic and true.

Security printing continues to offer a peculiar 'entanglement of past and present' (Parikka, 2012: 5). It is wedded to the past because of its long history, its reliance on mechanical and material reproduction, and its objects like banknotes and passports, which are centuries-old media artefacts. It belongs in the present because it produces things that are still needed and used, and because it continues to be at the cutting edge of scientific research. But whether 'old' or 'new', security printing operates at the periphery, then as now a 'quirky' and 'forgotten' (Parikka, 2012: 2) area of technical activity full of 'unsung and offbeat' technologies (Gitelman, 2014: 19). When we turn in its direction, however, we see that it offers a narrative of printing that does not lead to the accessibility of the digital copy but to a variety of other technologies and practices. Indeed, even when facing the threat of entirely born-digital replacements, such as digital currencies, security printing continues to reaffirm itself by making paper and printing secure and new.[12]

## The art and science of printing original copies

In 1737, looking for a way to protect banknotes, Benjamin Franklin invented the art of nature printing, using leaf casts made with a copper plate press to transfer the image of veined leaves (cut sage, raspberry leaves, fern fronds) onto paper money. In this moment, he 'shifts the burden of counterfeiting from copying the *content* of a note to discerning and iterating the *process* of its reproduction' (Trettien, 2017: 159, emphasis in original). He also exemplifies the story of a printer who, searching for ways to secure paper, would develop new printing techniques and demonstrates how security printing first emerges as an offshoot of more conventional printing, branching out in a different direction once the objectives of printing become not only quantity but also originality and quality. The history of De La Rue – by its own account today's 'largest designer and printer of

currency' – helps make this point. The beginnings of De La Rue can be traced to 1813 when a British printer of French origins, Thomas de la Rue, started a newspaper (*Le Miroir Politique*) making a point to specify that he would print on paper of 'superior quality' and generally for which he 'showed less interest in the content of the paper than the quality of it' (De La Rue, n.d. a: 2). Thomas then moved into stationary, eventually making his mark with his first patent, in 1831, for improved playing cards. His contributions included better quality oil colors, enameling, better color printing, as well as printing on the backs of cards with special designs, all of which contributed to making the cards visually refined and intricate using machinic processes and standards for ornamentation. He then transferred these skills to the production of other types of cards, from calling cards to train tickets (De La Rue, n.d. b). Thomas' son Warren continued in his father's footsteps. An amateur scientist, he cultivated an interest in chemistry and photography, which he was devoted to improving (Le Conte, 2011). The quality of his work stood out and was admired in his time, with scientific journals celebrating his celestial photographs as 'more beautiful examples of the printer's art than those produced in past years' (De La Rue, n.d. c: 5). De La Rue continued its commercial printing business building on Warren's printing skills, finally moving into the realm of security printing when they started producing stamps. Using their letterpress method, they also included a variety of other innovative features: special inks ('fugitive inks' that disappeared if someone tried to clean the stamp for reuse; carmine ink[13]), perforations, as well as noticeably refined engravings. This ingenuity gave De La Rue an 'aesthetic edge' (De La Rue, n.d. d: 2), which was essential in the budding business of printing inimitable copies and allowed them to expand their business in 1860 to the printing of banknotes. Paper money had been present in England since 1695, but De La Rue's first notes, for Mauritius, were notable for their inclusion of a variety of design elements: watermarked paper, green and blue colors, micro-lettering, floral ornamentation, and the treasurer's signature, in his own hand.[14] De La Rue has continued to produce banknotes ever since, adding passports to its repertoire in 1915. What can be gleaned from its story is how a printer moved into the realm of security by focusing on quality and the innovation of new techniques.

Like De La Rue, many of today's security printers have similarly long histories, notably Giesecke and Devriant (G+D) (1852), Orell Füssli Security Printing Ltd (1519, but 1827 as a security printer), Canadian Bank Note Company (CBN) (1897), or SICPA (1927). Their attention to quality and novelty would allow certain papers to at once be identical to and stand out from others. One important strategy for achieving this delicate balance is the bringing together of the manual skills of the craftsperson (e.g. the engraver) with newer technologies, making it an industry where 'tradition meets high-tech' (Orell Füssli Security Printing Ltd, n.d. b: 2). While we now speak of security printing as a coming together of art and science, in 19th-century England determining which it was was a divisive question. Indeed, there were two camps regarding the best way to secure money: the aesthetic camp, who believed counterfeiting was best deterred with 'greater artistic merit and complexity', and the technical camp, who:

> believed that the key to stamping out this crime lay in more advanced technology and materials, and perhaps more importantly a greater division of labour, whereby the skills used in each stage of production were so specialised that there was little potential for crossover between them. (Mockford, 2014: 130–131)

Today, these dueling positions have been hybridized, so that security printers explain their work as being both creative and technical. For instance, the US Bureau of Engraving and Printing (BEP) describes its work as 'one that involves highly trained and skilled craftspeople, specialized

equipment, and a combination of traditional old world printing techniques merged with sophisti-cated, cutting edge technology' (2018). This technical artistry has lead security printers to describe their banknotes as 'probably the best-protected artworks in the world', 'unique' and 'genuine' 'miniature' pieces of art, blending 'optical attractivity and security, fine arts and material scien-ce . . . aesthetics with functionality' (De La Rue, 2018a; G+D, 2018), so that it is precisely the marriage of art and science that together becomes difficult to counterfeit. Undoubtedly, the idea that these paper things are described as artworks despite their existence among a multitude of identical copies requires a rethinking of the material parameters of authenticity and firmly situates security printing as operating in what Nick Groom has called the 'dark corner of representation' that tries to parse the difference between originals, copies, counterfeits, and forgeries (2001: 6). Since security printers have the peculiar task of producing authentic copies, their story of printing puts innovative materials, complex composition, and unmatched quality center stage.

## Innovative materials: Printing sensibly

One reason it is difficult to categorically place security printing as 'old' or 'new' is that its novelty relies not on digital conversion[15] but on advances in material science.[16] This makes sense if we consider that one of the main tasks of the security printer is to make products that are difficult to counterfeit but easy to recognize, in other words that there is a vital 'need for material recognition' (Mockford, 2014: 179). But, while secure papers have been amply studied in terms of how they circulate as political, economic, or social artefacts,[17] there has been less attention on this material apparatus of security printing, one concerned with a 'sensible enquiry' of '*materials and their properties*' (Ingold, 2007: 3, emphasis in the original). Jack Mockford confirms this in his research on banknotes:

> Detailed discussion of the material characteristics of Bank Notes, as well as the methods used in their construction, have therefore tended to constitute merely a footnote in historical works that have often prioritised both contemporary and modern theoretical understandings of money and exchange. (2014: 119)

This is surprising if we remember that 'paper can function as money as long as people believe it is actually money' (Gilbert, 1998: 76): it can only function and circulate *if* it can establish authority on its own terms. This authority is established not only with symbolic and iconographic content – or *what* is being represented – but with the 'materials, marks, and processes' that produce the 'characteristic sensible qualities' of secure paper (Robertson, 2005: 41). For instance, already in the 10th century, an authenticating feature like the seal was 'evidently more important than the text itself' (Groebner, 2007: 157), while one of the consequences of the expansion of paper money in 18th-century England was that individuals no longer read the text printed, but rather 'relied on individualized material and visual "schemas" to help identify them as genuine' (Mockford, 2017: 28). The art historian Jennifer Roberts notes: 'without ornament, these notes simply would not be able to move' (2016: 308), and the same strategy applies to identification documents: 'It is not we who are checked, but the reproduced marks of authority, the stamps, and the watermarked counterfeit-proof paper whose security features gleam so promisingly in ultraviolet light. It is these authentically reproduced marks that validate our papers . . . ' (Groebner, 2007: 238). In other words, material and sensible features – visual or otherwise – are what authorizes the bridging of the gap between person or value, and paper.

The past 40 years have seen many digital technologies drastically facilitate reproduction: color copying, scanning, and printing, along with home-computer software tools.[18] Security printing has responded in parallel to these developments by continuously developing its physical features through material science research, providing trust through a sensory connection that is hard to achieve digitally. The Canadian Bank Note Company's Marc Gaudreau (Production/Materials and R&D), for example, describes their three new laboratories as 'equipped with technologies now that allow us to get to the ground truth of how materials interact with each other' (2018). Many security elements are the product of this research (e.g. threads, foils, or optical variable devices, but more on this multitude in the next section), notably inks and substrates. Custom or proprietary inks are a staple of secure papers. One security printer describes his 'exclusive special-effect inks' that 'of course are not freely available' (G+D, 2018), while the International Civil Aviation Organization (ICAO), which oversees the standardization of passports, offers some guidelines specific to inks, recommending at minimum that they include UV fluorescent ink and reactive ink, and suggesting a variety of other types, such as ink with optically variable properties, metallic ink, infrared absorbent ink, phosphorescent ink, metameric ink, or tagged ink (2015: App. A-7).

Another essential material element is the substrate itself. Far from being a blank slate, it is one of the most critical elements of secure paper. Among its recommendations for securing passports, the ICAO dedicates a section to the substrate, noting that these could include UV dull paper, two-tone watermarking, chemical sensitizers, invisible fluorescent fibers, and laser perforation (2015: App. A-4–A-5). G+D sums up the importance of the substrate when stating that '[b]anknote quality, security, and acceptance depend to a large extent on the material used to produce them' (2018). While the technologies have changed, the concern for a recognizable and unique substrate is not new. At the turn of 18th century, it was perceived that 'one of the most difficult elements . . . to imitate was arguably paper' (Mockford, 2014: 132). Already in the 12th century, paper had been made distinctive, including with coloring techniques like marbling, where patterns ('swirls and zigzags, stripes and crests, drops and tears') are produced by combining dyes and liquids that don't blend (Kurlansky, 2016: 191). The first English paper notes in 1695 were already marbled, and though the technique was a guarded secret, this did not make it an absolute form of protection. However, one type of information that could be conveyed through marbling or other substrate elements was provenance: paper could at times be traced to a country, region, or mill, and various features could also be attributed to a specific workshop or even a specific maker.

The watermark, first used in 1282, is another early example of a deliberate marking of paper. Papermakers would 'sign' their sheets with imprinted marks that could be seen when the paper was held up to the light and that assured that 'every single sheet of paper manually scooped out of a vat was an "individual"' (Müller, 2014: 72). In this way, 'watermarks tell origin stories and anchor paper in a system of time and space coordinates' (Müller, 2014: 72), and provide an assurance of quality and origin. Commercial processes that allowed for the integration of watermarks during the production of the paper (so that the Bank of England, for example, had an exclusively made watermarked paper) made the job of the illicit copier particularly troublesome.[19] Most counterfeiters would not have access to paper-making facilities and would have to recreate the appearance of the watermark by adding it onto a paper rather than into it (Mockford, 2014: 139–142). Watermarks directly embedded in paper are still considered 'a first step in banknote authentication', thanks to their 'distinctive appearance' and the fact they are 'extremely difficult to replicate faithfully' (G+D, 2018).

Today, the substrate can be made from cellulose-based paper (using cotton, linen, hemp, silk, tree pulp, etc.) or from synthetic substitutes like polymers or polymer blends, transforming 'paper'

into a thin plastic substrate. Organic paper is sensitive to environmental conditions and the wear-and-tear of use. Polymer is by many considered superior to traditional paper because it is 'cleaner, safer and stronger' but also because it can 'provide enhanced counterfeit resilience and increase the quality of notes' (Bank of England, n.d.: 4).[20] Whether on paper, polymer, or hybrid, the objective is to make security features that are inseparable and integrated into the substrate:

> . . . consider that when banknote paper is delivered to the print works, in addition to watermarks and security threads created in the paper, the paper often already incorporates silk screen-printed security features, gravure coatings, applied foil and a wide range of security features . . . (De La Rue, 2012: 10)

Starting with the substrate itself then, the making of secure paper requires unique and recognizable physical features, which calls for an understanding of printing that is in dialogue with material science, and that evolves as materials evolve. To take full advantage of this material orientation, security printers rely not on singular elements but on a multiplicity, creating compositions that are all the more difficult to print.

## Complex composition: Printing layered wholes

Alongside material specificity, another characteristic of security printing that complicates new/old divides is its reliance on a multiplicity of techniques, producing papers which themselves contain layered and composite histories of printing. Together with the aforementioned inks and substrates, there are many other components in secure papers, both high-tech (e.g. color shifting images, holograms, micro-mirrors, various security threads, foils) and more traditional (e.g. intaglio engraving, lithography, silkscreen, foiling, letterpress). It is difficult to determine precisely how many such elements there are in secure papers: De La Rue (2018b) says there are 'over 400 security features' in the UK passport it produces, while among the strategies that have been disclosed in the Canadian passport are multi-color intaglio printing, rainbow printing, and multi-color invisible printing; latent images, guilloche patterns, and anti-copy features; optically variable inks, metallic inks, UV inks, IR transparent inks, and IR opaque inks; laser perforation of pages, variable tactile laser engraving, and embossed tactility; and the list goes on (CBN, 2018b). The ICAO presents the basic requirements as two-color guilloche background pattern, rainbow printing, and micro-printed text, while additional recommended features include intaglio printing, anti-scan patterns, relief (3-D) design, tactile features, and unique fonts (ICAO, 2015: App. A-7). Meanwhile, describing their banknotes, G+D says: 'With highly precise intaglio printing, variable and dynamic 3D effects including secure windows, complex security threads, invisible magnetic, infrared, or UV features, and more, we turn every banknote into an inimitable piece of high-tech' (2017: 17). The Bank of Canada has presented eight distinct elements for its newest note, including the polymer substrate (2018), while the Bank of England says there are approximately 10 features that can be publically recognized (Bank of England, n.d.). In other words, for security printers, a secure paper is not just a singular object but a collection of material and aesthetic elements, showcasing 'a multitude of design disciplines working in unison' (De La Rue, 2018a) to overwhelm the counterfeiter with the sheer complexity of its layered compositions.

This composite strategy is a response to the conditions of security printing, which do not tolerate any reduction in quality from the copying process. In security printing, a copy cannot be made from a copy, only from the master template.[21] This matrix is the only 'original', and every print it produces is an original copy. This matters insofar as distinguishing between the copy and original lies at the heart of much of our thinking about mechanical reproduction. In this context, the major

challenge is to convey authenticity in things that are the same (repeated) but also different and distinct. By claiming that the original loses its authority once it is mechanically reproduced, Walter Benjamin canonically positioned authenticity as an opposite of reproduction: 'The presence of the original is the prerequisite to the concept of authenticity' so that 'the whole sphere of authenticity is outside technical . . . reproducibility' (2007: 220). But, as Vladimir Groebner argues, 'whether or not reproductive techniques generated original, duplicates, or forgeries was a matter of context' (2007: 184–188). In security printing, authenticity is divorced from a notion of the singular original, producing a situation in which it is precisely printing that produces authenticity. After all we say that we *print* money rather than *copy* it, an indication of the value of each physical specimen. The copy is *not* the lesser cousin of its original, but a print, mirror, or child[22] of the archetypal matrix, each printed copy beaming with its own truthfulness, looking and feeling *right*.[23]

The constraints of security printing ultimately shape the way that copies must be made. To start, the original matrix brings together the various security elements that make the composition. What happens next can be explained using Hillel Schwartz's distinction of copying s/t/r/o/k/e/-/b/y/-/s/t/r/o/k/e and copying in the ENTIRETY, a distinction that lies at the heart of security printing (1996: Ch. 2, his style). The difference lies in whether the copy attempts to reproduce the original in a piecemeal manner, and to follow the original process of making, or whether the copy flattens the original to copy it as a uniform whole. With s/t/r/o/k/e/-/b/y/-/s/t/r/o/k/e copying, every element has to be reproduced faithfully, replicated with material accuracy from its master. This is the logic already implicit in the copying of money in the 17th century, when what would be needed was 'a properly engraved plate, the right ink, and the correct paper' (Levenson, 2010: 197), precisely because the copy had to accurately reproduce all of the elements in their rightful material composition. On the other hand, a digital copy is an example of copying in the ENTIRETY, whereby material becomes compressed information, losing the diversity and specificity of each element: 'counterfeiting of this type is not intended to duplicate the processes used to make genuine banknotes, but it instead simulates the result with much-less-expensive equipment' (Committee, 2007: 9). It is a copy that remains in the realm of simulation.

In order to produce this composition, security printers emphasize the bringing together of 'creative specialists and technical experts' (De La Rue, 2018a). Julian Payne, De La Rue's Creative Design Director, describes this symbiotic relationship:

> You have security feature designers, and substrate designers working side by side with the print designer, and that's really really important because when you're trying to create security in the sort of documents that we make whether a banknote or a passport, you're looking to layer the security. And if you don't have those designers working side-by-side, I think you compromise the security, you compromise the narrative that you're trying to create, that the public will authenticate through it. (De La Rue, 2018c)

Security printing thus provides us with an ornamental 'baroque complexity of security features' (Gitelman, 2014: ix), a high-tech throwback to the aesthetics of abundance, maximalism, busyness, layering, and complexity. This decorative quality is both aesthetic and technical, inefficient but also essential as a reaffirmation of identity and authenticity through the multiplicity and repetition of features and techniques. It makes the security printer 'an "integrator" of technology' that 'combines paper, inks, applied features and printing processes to create the whole' (De La Rue, 2012: 11). Copying s/t/r/o/k/e/-/b/y/-/s/t/r/o/k/e requires all of the skill and know-how, all of the right materials, tools and equipment, making the job of the counterfeiter increasingly difficult.

Illegitimate copies might appear genuine at first glance or touch, but a closer examination and verification of its assorted components will usually reveal material disparities and subpar quality, whether of distinct elements or in their integration into a whole.

## Matchless quality: Printing better than everybody else

Thanks to this careful material selection and composition, secure papers are quality objects, and this need for distinctive and noticeable quality is what continues to propel (security) printing into the new. Already in his 1854 essay on banking, Granville Sharp described the need for paper to have the regularity – that is, quality – of a machine-made artefact: banknotes were 'to be made of paper absolutely distinctive in color ("a peculiar white neither sold in shops nor used by any other printer"), thinness and transparency, characteristic feel (crispness and toughness), watermark, finish (three deckle edge), and strength (one note should be able to support one half-hundred-weight)' (in Robertson, 2005: 37). Such features could only be produced using a mechanical process, so that 'the authenticity of each note was there to be checked by very fine, if almost unconscious, sensory judgments of sight, touch, and sound, against a background of preestablished uniformity' (Robertson, 2005: 38). In other words, if printing can be understood as a technology that made the process of putting words on paper clean, efficient, neat, and precise (Schwartz, 2014: 183) through a mechanical reproduction that facilitated the manufacture of identical copies, this standardization also 'had the negative effect of increasing the possibility of fraud' (Robertson, 2010: 38). In this context of access, what would matter would be precision and execution.

In the 19th century, printing and engraving were already accessible to many, and security printers needed features that would provide the 'irreproducible' quality of a document. They also had to, then as now, convince and educate the public using 'public standards of judgment' (Robertson, 2005: 34), making sure that distinguishing the real from the fake was easy and intuitive. As noted above, these standards would take shape in physical qualities and the belief that certain features were marks of authenticity. The same values persist today. For example, the Bank of England educates the public to: 'Check the print quality. The printed lines and colours on the note are sharp, clear and free from smudges or blurred edges' (Bank of England, n.d.: 6). The emphasis on quality is one example of how the materials in printing constitute part of 'the protocols that enable paper to work' (Robertson, 2014: 70) *as* currency or *as* identification document. It is also here where security printers must always strike a balance between being novel and making sure that the public knows how to evaluate the qualities of authentic papers.

All this puts the emphasis on *how* information is presented, so that in security printing there is a world of difference between printing, and printing *well*: 'quality is not just a catchword. It is the philosophy we live by' (Orell Füssli Security Printing Ltd, n.d. a: 3). The attention to quality and skill is at the heart of the work of the security printer, with aesthetics and functionality matched through 'precision engineering' (De La Rue, 2011: 16). Quality is equivalent to value, not only because it represents it but also because it produces it. In one promotional video, De La Rue describe their attentiveness to detail and precision ('to the micron level'), the care in both the aesthetic design and its technical execution, and the need for each member of the team to be a perfectionist in what they do. A Technical Design Team Leader says: 'You have to get it right. Because the end product . . . What the customer is asking for is . . . perfection. You can't have anything less than that' (De La Rue, 2018c).

The matter of *how* is also a question of *who*: who can determine the standards and produce them with the required accuracy. Many features and compositions can only be correctly made by those

with access to the right machines, tools, and technologies (Levenson, 2010; Robertson, 2005), so that working with difficult or expensive equipment and instruments is a way of controlling illicit (re)production, achieving 'maximum security due to exclusive production processes' (G+D, 2018). This is a strategy of a 'technological divide' between official printers and counterfeiters in the name of 'protecting the public' (Mockford, 2014: 2).

Ultimately, trusting paper documents in not only a question of social construction but very much a material judgment, one that explains the need for security printing. By putting the emphasis on quality alongside quantity, security printing places printing not only as the technology of dissemination and accessibility but also one of discrimination: security printing is reserved to a specialized subset of perfectionist printers and their discerning customers (and of course, we are all the users). Counterfeiters are illegitimate printers because they are producing without authorization and because they do not print quite well enough, encroaching upon a kind of printing controlled by the few where rarity is measured not in terms of scarcity, but quality.[24]

## Conclusion: A continuous expansion of printing

The work of De La Rue was praised in the 19th century, including in a feature for *The Art Journal*, where one critic noted that the company is 'distinguished by a high degree of mechanical excellence and by a great fertility of idea' (De La Rue, n.d. e: 3). Both of these attributes continue to play a crucial role in security printing: quality and novelty. 'Why innovate?' asks one Chief Technology Officer: 'Because it's what the counterfeiters do' (De La Rue, 2018d: 10). This is the perpetual challenge of the security printer – if I can do it, so might somebody else. Seeking to always be 'one step ahead' (G+D, 2017: 8) in terms of the materials, complexity, and quality of their products, security printers have to respond to customers – banks, governments – who often 'want something that isn't in existence right now' (CBN, 2018a). The workshops of yesteryear have now been replaced with R&D divisions equipped with scientists from high-tech fields – nanotechnology, photonics, polymer development, holography, and so on – and the promise of originality and innovation permeates the way security printers present themselves. De La Rue (2018a) boasts that it has invented over 100 security features for currency, that it holds 1000 patents, and that it registers around 30 new patents every year, while in 2015 it announced in its strategic plan that by 2020 it would no less than double its investment in R&D. G+D meanwhile registered 171 patents in 2016 alone (2017: 9). In their marketing, security printing companies promote their 'space-age technology' (De La Rue, 2018a) as variably innovative, exciting, pioneering, world-leading, unrivalled, unparalleled, state-of-the-art, world-class, highly complex, next-generation, trailblazing, ground-breaking, cutting edge and leading edge.[25] All this energy is meant to assure consumers that these printing technologies are 'absolutely' 'future-proof solutions' (G+D, 2017: 6) that will stave off counterfeiting 'both today and tomorrow' (De La Rue, 2018a).

To include secure paper in the larger media history of printing is not so much about excavation as it is about narrative. It is about shifting our attention from artefacts like books, printed ephemera, or artworks, to those that work to maintain and secure (social, political, economic) order. It is to recognize that these artefacts circulate with authority because of their sensible material qualities, and that these cannot be stagnant and fixed. Thinking about this material *how* of security printing provides a historical and theoretical bridge between the past and the now that expands the ways we think about printing itself. It is an example of an industry in which the old is not outright replaced by the new, where digital does not outright replace analog. Rather, anchored in tradition while searching to stay one step ahead, security printing keeps making printing new, again and again.

## Funding

## Notes

1. John Sturrock's 1978 translation for the Penguin Classics edition uses 'printing press'. In French: '*L'invention de l'imprimerie est le plus grand événemenet de l'histoire*'.
2. Unless specified, 'papers' is used here in a general sense, to refer to both an organic cellulose-based substrate and one made of polymers. More on this below.
3. Security printing can also include a broader spectrum of activities, including the management of identities or consumer goods through data, databases, track-and-trace technologies, and so on. Many of the companies discussed here also provide such digital solutions for the securing of identity and authenticity.
4. A manual from 1897 describes the printing press of 1837 as 'in principle probably identical to the one used by Gutenberg in 1450' (Southward, 2010: 23–24).
5. Not considered here however are machine-readable features such as magnetic strips or chips. See Kaminska (2018).
6. Specifically, of content available on the websites of the security printers De La Rue, Giesecke and Devriant (G+D), Orell Füssli Security Printing Ltd, Canadian Bank Note Company (CBN), and Bureau of Engraving and Printing (BEP); customers like the Bank of England and the Bank of Canada; and bodies like the International Civil Aviation Organization (ICAO).
7. Some historians do include, to varying degrees, paper money and passports as ephemera (Rickards, 2000; Taws, 2013; Twyman, 2009).
8. The narratives of media technologies remind us that these are not fixed and objective innovations, so that the unearthing or writing of new narratives is also a multiplication of meaning. See Natale (2016).
9. By the Empress Shōtoku, who distributed a Buddhist spell (*dhāraṇī*) by having it carved into blocks (of wood or metal), and then printing it one million times on bits of paper.
10. For example, understanding lithography as a 'cheap way to print' (Meggs and Purvis, 2016: 173) helps explain why it became 'so popular, its practice so widespread' (Robins Pennell, 1898: 53). Other reproductive technologies – photography, the digital, and so on – then continue to provide ever-more 'cheap and easy' (accessible) ways to make printed copies.
11. Frances Robertson notes the use of this pejorative term in the slang of the mid-19th century (2005: 31).
12. Security printers are the first to remind us of the ongoing need and use for physical currency. According to De La Rue (2018a; 2018b), 85% of the world's consumer transactions are done with currency, while a third of the world's population is unbanked, meaning they do not have access to forms of payment other than cash. G+D claims that 80% of transactions are made in cash and that this is growing by 5% each year (2016: 13–14).
13. Most of De La Rue's records were lost in the blitz of 1940, but it is thought that De La Rue played an important role in developing synthetic pigments (Reinhardt and Travis, 1997).
14. According to De La Rue, there are no records of this note ever having been counterfeited (n.d. e).
15. While a contested term, 'new media' is still often equated with the digital. See, for example, Manovich (2001).
16. By printing three-dimensional objects using polymers and other substances, 3-D printing is another example of a materially oriented printing, referring not to something done *on* a substrate but to the shaping of substrate into form.

17. For example, on money see Gilbert (2005); on identification documents see Caplan and Torpey (2001) or Robertson (2010).

18. Until these technologies became widely accessible starting in the 1980s, counterfeiting 'required considerable artistic and technical skill, as well as substantial resources' (Committee, 2007: 9).

19. In England, moulds for the paper were kept for safekeeping at the Bank, sent to the paper mill only as required, and the Bank also had a representative at the mill 'in order to "oversee" the making of the paper'. As soon as the paper was made, it 'was locked in massive iron-bound chests' (Mackenzie, 1953: 37).

20. Not everyone agrees. G+D for instance promotes its cotton or cotton-polymer substrate by noting that 'cotton paper is ideally suited to integrating tried-and-tested, innovative security features' (2017: 23) and by arguing the converse, that certain security features 'are simply not possible in banknotes made purely from plastic' (2018).

21. For a description on how the template is made, see for example, 'How Money is Made – Plate Plating', at BEP (2018).

22. Based on Müller's description of the watermark, where he compares 'the sheet formation process to an act of birth, whereby a watermark is imprinted on the paper like a birthmark' (2014: 72).

23. Original art prints are another example of when copies are treated as authentic. As Hillel Schwartz (1996) shows, copies are much more complex, significant, and legitimate aspects of human culture than is usually recognized.

24. See McKitterick (2018) for a discussion on rarity.

25. Terms found repeatedly across the gamut of materials consulted.

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