

The Intrinsic Value of Valuable Paper: On the Infrastructural Work of Authentication Devices

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Abstract

Authentication devices transform cheap paper into legitimate documents. They are the sensory, informational, and computational features that make up valuable papers like banknotes and passports, and they provide the confidence required in moments of exchange and passage. These devices – which include techniques like watermarks and specialized threads, proprietary substrates and inks, or RFID chips – are the product of security printing, an industry that continuously reinvents the possibilities of paper. Importantly, these components protect paper things from counterfeiting, allowing it to function as an original and authentic copy and to do the logistical work of connecting quotidian materials to global networks. The value of valuable papers is therefore not purely extrinsic, socially or discursively established, but is also performed through its intrinsic material qualities. These are the authentication devices that are read, assessed, and trusted as paper things are circulated, and they are what securely connects paper to infrastructures of mobility.

Keywords

authentication, device, infrastructure, logistics, money, paper, quality, security, value

Quality is a vital component in a finished banknote because it helps preserve its value. (De La Rue, 2015)

From its beginnings in the Europe of the 17th century, paper money was a hard sell.¹ Currency up to that point was literally weighty with its own value, with metal coins containing and not just representing their worth. Having the value of metal stand for itself was an obvious and intuitive way of conceiving of money, and there was great difficulty in convincing

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the public that they should trust the flimsy, cheap, and accessible technology that was paper to do the same work. This situation was somewhat different in North America where metal coins were received from Europe, a system that helped maintain colonial order. In the United States, for example, arguments arose between the 'greenbackers' and the 'bullionists', a reminder that neither coin nor paper was a more 'natural' social convention (Carruthers and Babb, 1996), while in Quebec an ingenious use of playing cards during coin shortages also illustrates a willingness to make paper work (Gilbert, 1998). Whatever the context, the move to paper money required changing the way people interacted with paper, namely by drawing their attention to the various physical and material features that characterized and distinguished the carefully produced valuable paper of state documents, like banknotes, from the disposable paper of products like newspapers. The idea that paper could be as valuable as gold was, for many, only explicable as an 'act of social wizardry' (Carruthers and Babb, 1996: 1558) or as the outcome of a supernatural transformation (Weatherford, 1997).² This falling back on mystical phenomena as explanations for paper's conversion to legal tender or document underlines the incredible feat that it was to elevate paper as a material that could be accepted by the public as a transactional medium, one that could circulate and move about across space and time, steadily and credibly.

There are many ways that scholars have studied official paper artefacts like passports and banknotes, probably two of the most complex media of human culture (and the examples used here). Yet, they have also 'become so naturalized that [their] mundane power is rendered invisible: we don't think twice' about the coins, bills, and identification documents that we use on a daily basis (Gilbert, 2015: 301).³ Passports are meaningful and efficient 'paperized' carriers of information, working with categories and standards to organize, define, and mediate identity and citizenship (Robertson, 2012; 2015), while paper bills can be ambiguous artefacts associated with the abstraction of value. Indeed, the shift from a 'metallic idea of money' (Shin, 2015: 417) to one that is paper-centric⁴ is generally understood as a transformation of currency from having intrinsic to extrinsic value. Unlike with metal coins, 'notes had to confirm themselves as a new form of monetary identity and to train their holders not just in new ideas but in new practices of assessing objects and understanding value' (Brunton, 2019: 25; emphasis in the original). This aptly sums up the popular 'birth story'⁵ of valuable paper: a difficult passage from the self-contained quantifiably valuable currency of metal coins to one where value would be abstracted and beyond measure, represented in what was considered as inherently cheap paper (Bender, 2006; Gilbert, 1998; Robertson, 2005; Shin, 2015; Weatherford, 1997). It has been argued that in banknotes 'physical characteristics are essentially irrelevant to its monetary role' (Carruthers and Babb, 1996: 1556), that these

'flimsy papers' could circulate as valuable not because of their material qualities but thanks to abstract beliefs and a shared collective and individual trust in the underlying system. From this point of view (one which had to be learned when paper money was first introduced), the only thing that can protect money is 'people's confidence in their political systems and leaders' (Weatherford, 1997: 188), meaning their faith in the issuing authorities that make and produce these bits of paper. Along these lines, Marcus Boon (2013) remarks that authenticity is a designation and not an essence: the transformation of paper into money would therefore be the result of social convention rather than (or at the expense of) the work of and a mediation through material qualities. While certain moments of circulation require the public to assess and recognize the 'objectness' of paper as physical artefact (e.g. to subconsciously know if a note feels right as it passes through our hands), this crucial sensorial dimension has not taken much space in explorations on the birth, life, or performance of paper as official document. The goal here is to contribute to a digging into the material sensibilities of valuable papers, to an understanding of how they work in moments when they must prove their authenticity on their own merits.

Researchers from many fields, including media, art, and design, have provided some careful research into the make-up of these powerful paper things. Often this has been through interpretative work, combing through the meaning of the abundant visual detail of official documents. The prevalent use of symbolic and nationalistic imagery (Gilbert, 1998; Hawkins, 2010; Lauer, 2008; Weatherford, 1997), for example, provides insight into the historical, social, and political systems in which they circulate. In identification documents like passports, attention has also been placed on elements like signatures, photographs, and fingerprints (Cole, 2002; Fahrmeir, 2001; Hausken, 2020; Robertson, 2012), all of which eventually become regulated with strict standardization protocols. Valuable papers also contain a variety of other techniques. Among a long list, this includes marbled and proprietary paper, custom inks and threads, holographs, or foils (Bender, 2006; Fahrmeir, 2001; Groebner, 2007; López-Bosch, 2015; Mockford, 2014); original processes like nature printing (Roberts, 2017; Trettien, 2017) and codification systems like serial numbers and barcodes; and the use of ornamentation more generally (Roberts, 2016). These all work as authentication devices for official papers: they constitute the specific techniques and material qualities that are, as will be argued here, *valuable*, working to distinguish these papers from the 'cheap and flimsy' through technical detail, complexity, quality, and novelty. Seen through this material lens, valuable papers can therefore be recognized as having *intrinsic* value.

The material production of valuable papers thus turns our attention to the collection of sensory, informational, and computational features that contribute to making them recognizable as authentic. These tell a

particular story of paper and of printing,⁶ one that leads to a recasting of passports and banknotes as some of our most technologically sophisticated quotidian objects. Significantly, by doing the work of inscribing legitimacy, these features become *devices* of authentication and security. They are devices – a largely understudied concept in the history and philosophy of technology – that play a fundamental role in how such paper comes to function and *work* for a particular purpose. Authentication devices are what give a paper its authority and value, and they do so in part through their logic of ‘irreproducibility’: while devices can be reproduced by the right producers, their power comes from the copy being, at least momentarily, out-of-reach to amateurs or counterfeiters alike. This assures that each copy is authentic, so that devices ultimately act as the small but essential logistical components of infrastructures that help regulate reproducibility and mobility in the name of security.

Underlying this proposal for thinking the epistemological dimensions of authenticity and of authentication practices (‘know-show’⁷) is the question of how authenticity is delivered in material techniques, or how, why, and when certain things become trusted as real.⁸ To examine these questions, the first section begins by considering paper as a technology we have learned to trust. Part two provides closer detail on the devices that inscribe, communicate, and mediate authenticity. The last section articulates how such devices do the work of security and authentication that is required in the infrastructures in which people and things on the move must continuously prove themselves. The overarching goal is to consider how media studies can address and fold in these forgotten devices that authenticate and secure the world of things. Specifically, the objectives are to show that such devices transform the ‘valueless’ into the *intrinsically* valuable, so that our trust in paper relies not on mere ‘unsubstantiated’ faith, but on a trust with material substance that allows official papers to be exchanged, circulated, and evaluated with authority in global networks, systems, and infrastructures.

Trusting Papers Sensibly

In theory, traditional metal coins contained the weight of their value in silver or gold but, unsurprisingly, counterfeiters, kings, and queens alike eventually stretched this truth, cutting the precious metals with cheaper alternatives that resulted in underweight coins. Already then began the separation and abstraction between value and material.⁹ Paper bills make their first appearance in Europe in Sweden in 1661 but take time to take hold: there is a new kind of work required to create this abstract relationship between the thing and the meaning of the thing. The public needs to develop its confidence in paper, and this is something that both takes time and that happens in fits and starts. The Swedish paper

bill did not last, and even in the US – ‘the cradle of paper money’ – \$13 million worth of banknotes printed by 1777 became worthless three years later, mere paper. Paper notes reemerged in the US only almost a century later. The problem had been one of trust: ‘Aside from . . . faith, nothing backs up the dollar’ (Weatherford, 1997: 180). As media scholar Finn Brunton writes, a bill ‘is only valuable to me because it can pass out of my hands. It is an abstract quantity, capable of becoming anything from an act of generosity to a fire extinguisher, but it exists in practice in terms of concrete quality’ (2019: 30). While the specific value of a paper bill is not connected to a precise calculation of its material components, it becomes valuable when these can be recognized as having the qualities of the authentic. Quality, that ‘common but nevertheless mysterious practice’ (Easterling, 2016: 179), is something we spend little time thinking about, but it is often the subconscious explanation for why we have faith;¹⁰ in other words, while some qualities are intuitive, others we learn to know and trust (Robertson, 2005). In his foreword to Georg Simmel’s treatise *The Philosophy of Money*, Charles Lemert muses on the question of faith in paper by drawing our attention to the shifting understanding of what money is:

Yet, money as such is nothing in and of itself. Even the coins are all but devoid of precious metals and the paper stuff is nothing more than paper with encrypted print. Bank notes are no longer backed by any commodity more precious than a vague confidence in the economic communities that print them. Yet, it would be hard to name a thing more central than money to modern life; hence, the mystery as to why money is so little understood inversely to its enormous importance in our daily lives. (2011: viii)¹¹

Paper was a great alternative to metal coins for many reasons, most significantly that it was lighter and cheaper. But it did not come without its own set of challenges. Not only was paper available to the public,¹² but the other tools required for producing bills – a press, molds, inks – were also already widely used, whether by artisans, craftspersons, or publishers (Levenson, 2010; Robertson, 2005). The industrial revolution had made the mechanical reproduction of printed paper things an everyday activity, with newspapers, postcards, cards, and other common artefacts produced in mass quantities. To print quality paper and to reproduce it was, at least in principle, as feasible for banks and governments as it was within reach for the general public.¹³

Official papers, which often exist simultaneously as multiples and originals, have a particularly complicated relationship to reproduction. This is, after all, a register of reproduction concerned with restricting the circulation of knowledge regarding the techniques, materials, and methodologies used in the process. Authentication devices are thus the

result of a continuous wrestling between usability on the one hand and opacity on the other, driven not by aspirations of unfettered mass production or consumption, but rather by the need for the controlled management, administration, and governance of access, authenticity, legitimacy, and 'originality'. The same basic problem of the 18th century still exists in the digital present: advances in new technologies of copying and printing, as well as accessibility to high-quality consumer color scanners and printers, have made paper copying easier than ever (Anderson, 2008; Boon, 2010; Schwartz, 2014). For the security printer, the challenge with this newfound-accessibility is that it sets the conditions for a boom in counterfeited printed goods. In today's context, "digifeiters" do not require any significant abilities but for operating widely available image processing software on a computer, connected to a quality ink jet or a dye sublimation printer' (Van Renesse, 2000: 96). It is in this context that we have to evaluate the production of valuable paper and the challenge to which it must respond: producing papers that cannot be easily reproduced, that bear the mark of legitimacy and authenticity despite the growing ease of reproducibility.

As Lisa Gitelman remarks in her work on documents, 'looking official is both a tall order and a moving target' (2014: ix), and this is the challenge faced by security printers: they must print paper that only they can make and reproduce, outdoing and outpacing the skills and tools of amateurs and professional counterfeiters, who are never many steps behind. This cycle has been described as a 'technological race' between issuers, regulators, and forgers (Fahrmeir, 2001), one that motivates security printers to continuously produce new elements that will be, for a time at least, 'copy-proof' or 'irreproducible'. They do this namely through the innovation and incorporation of new material features that are hard to produce and copy, requiring sophisticated machines, components, and know-how, as well as large investments in the tools and equipment required.¹⁴ In other words, the threat of the fake guarantees constant novelty, so that in the realm of security, paper is perpetually 'cutting-edge' and 'high-tech'.¹⁵

Unfortunately, as we know, we cannot successfully photocopy valuable documents like banknotes on our home printers. We know that there is an informational loss in the photocopying process, which only reproduces surface information, flattens it and empties it of the material complexity of the original. In her study of mechanical reproduction, art historian Tamara Trodd (2015) notes as much, arguing that it is the photocopier that destroys the distinction between different media. This is the result of the work done by security printers that guarantee something largely and instinctively taken for granted: that we, the general public, cannot successfully replicate the artefacts they produce. Official papers meanwhile are multi-media objects, rich with multi-sensory data and distinguishable forms that rely on the quality of the material

inscription, each authentic copy preserving this material intricacy and integrity. When a paper is stripped of these sensory qualities, it doesn't look or feel right, and we detect it as false.¹⁶ This sensorial interaction results in the performance of a kind of 'calisthenics', where we hold the paper in and out, where we finger it and flip it this way and that (Gitelman, 2014: ix). Brunton also draws attention to this very handy relationship with paper notes:

We may know this through ductility, thermal conductivity, and sound: biting a coin, seeing how fast ice melts on it, the 'ping test' of its chime when struck. We may know it from the smell and weight of a brick of compressed tea, the branding and bands on a cigarette, or through serial numbers, signatures, paper stock and fabric's 'hand,' and the security threads and watermarks on banknotes, letters of credit, or traveler's checks. We know all these things in the context of training, habit, and prior experience. (2019: 2)

Book historian David McKitterick also makes a similar point:

It has been often enough stated that the meaning of a document – manuscript or printed – is linked to its material form [...] Tactile, spatial, visual and even olfactory and audible characteristics all contribute to this process. The quality of paper, and something of its history, can be detected in its sound as it is turned, stroked or rattled. (2018: 69)

These sensory assessments and material evaluations are the way we establish the value, identity, and authenticity of analog things. With paper documents, what is specifically being assessed are the multitude of authentication features that display, communicate, transmit, mediate, and 'fix' the realness of things through a circular process whereby they authenticate by being able to reveal their own authentic quality. In doing so, they protect the materiality of an object, so that to copy it must mean to not only reproduce its appearance or surface (a *showing* of its content), but also to copy the way it is made (through a *knowing* of its form).

Authentication devices are the result of a continuous tug-of-war between, on the one hand, usability and legibility and, on the other, opacity, protection, and secrecy: indeed, 'about those who make the banknotes we know next to nothing' (Bender, 2006: 33).¹⁷ In this shadowy environment, one challenge is to always ensure that the public knows how to read devices as trustworthy, even as they are continuously updated and upgraded. After all, what becomes crucial in assessing authenticity is not *what* is printed but *how*. So far there has been considerably more time spent deciphering the iconography, symbolism, and information included on our official papers than on understanding the

value that ultimately comes from these signs and symbols being inscribed and read in the right way. This matter of the *how* is when we come head-to-head with the high costs of printed authenticity and of the sophisticated devices that can produce it and control it effectively.

Devices for Making Valuable Paper

Valuable papers are technical and material compositions performed by a cast of authentication devices. Elements like wax seals, watermarks, or stamps can all be conceived as part of a long history of document aesthetics and paper security. This has led to strategies of imaging and display that take advantage of new technologies: holographs and other optically variable devices, see-through polymers, guilloche, fluorescent thread, specialized inks (e.g. thermochromic), kinegrams, and microprinted features. These can in turn be applied in representational elements like seals and emblems, signatures and portraits, but also in the more abstracted patterns and ornaments that give official paper their busy and 'baroque' aesthetic (Gitelman, 2014: ix). Tactile effects, or elements that can be detected through touch, include substrate composition, which gives the distinctive feel of the synthetic polymer of Canadian bills or of the cotton-linen blend of American paper notes. It can also include techniques like intaglio or letterpress that inscribe the surface with textured reliefs and depressions. Many of the qualities that allow for the assessment of substrates – such as opacity, gloss, or texture – can be evaluated through the interplay of sight, touch, and even sound. What characterizes all of these overt devices is that they make authenticity legible to human perception. They rely on the human ability to recognize so that a person can evaluate, through sensory means, the legitimacy or authenticity of a device, and thus the thing (or by extension person) that it is securing.

Strategies for overt devices like miniaturization and concealment are also blueprints for their covert counterparts,¹⁸ which opt for strategies of invisibility and connectivity. Covert devices are generally understood as those that require the assistance of a machine to perform their authenticating function. Some authentication devices are covert because they are imperceptible to the naked human eye: they are either too small and must be magnified, or exist outside of the visible spectrum. Such devices are made *visible* by machines (e.g. microprinted text or invisible inks that can only be seen with UV light that 'reveals' them). On the other hand, there are those devices that must be *read* by machines. These assume the encoding of information, which must then be detected, decoded, processed, and made sensible using a computational intermediary. They can include, as Matthew Kirschenbaum has noted, images that carry metadata, steganographic images, or digital watermarks, all of which 'become visible when the data object is subjected to the appropriate

formal processes, which is to say when the appropriate software environment is invoked' (2012: 13).

A non-visual example of machine-readable authentication devices are 'track-and-trace' technologies like radio frequency identification (RFID) tags. These serve an important function in the logistical systems that support global trade and other circulations, and they also alert us to a key feature of authentication devices: they are technologies on the move, 'immutable mobiles' (Latour, 1986: 7) doing their work in space and time.¹⁹ RFID tags are included in passports, tracking the movement of citizens across borders, working at the convergence of trends in mobility and datafication (Frith, 2019: 1). Authentication is here directly related to the ability to monitor people and things in movement. We can see this also with other uses of RFID tags, not just as integrated in paper, but also within the broader management of global trade, where they provide the ability to follow individual products from the moment they are manufactured to their arrival in the hands of the end customer. Each product is assigned or encoded numerically, using a unique serial number, Electronic Product Code (EPC), Serialized Global Trade Identification Number (SGTIN), and/or other conventional system of identification. These 'e-pedigrees' are then collected and stored in databases that can then track the movement of the item through the supply chain by noting locations, timestamps, and the details of each transaction as an object is 'produced, packed, shipped, received, and examined' (HP, 2003: 6). With RFID tags, then, evidence of authenticity is not in the materiality of the object or the body of the subject²⁰ but contained in its data. As technologies of connectivity, such authentication devices forge secure links between materials, databases, and networks that protect (digital) data. Thus, authenticity becomes constituted through all of the stored data that together can explain how this thing got to be in this place, starting with the facts that are able to prove its 'context of production' (Robertson, 2014: 79), location, and movement within accepted sites and networks of exchange, migration, and circulation.

Track-and-trace technologies are an example of machine-readability that breaks down authenticity into recordable evidence in the form of specific facts.²¹ The International Civil Aviation Association (which determines passport standards) decided in 2015 that all passports must be machine-readable (ICAO, 2015). A machine reads data to establish not merely that this document belongs to that person, but to authenticate the record of this person by connecting and matching it to a database that legitimates and verifies that this person has 'real' data, in the sense of validating that the data in the document presented corresponds to that stored in the system (Zureik and Hindle, 2004). In effect there is a 'perceived need to lessen the role of individuals' (Robertson, 2012: 17) in procedures of identification, and a belief that we should use and trust machines in the determination of authenticity (Lyon, 2009). By gradually

shifting trust from the ‘human touch’ of the artisanal and crafted to the machinic, the quality of authenticity would become inextricable from that of standardization and (perfect) technological repeatability (Robertson, 2005: 36–41). Authentication becomes objectified and quantified, one further example of the long ‘de-humanizing’ history of bureaucratic and logistical procedures. These elements are ‘tracked’ as official facts and become the record that establishes the authenticity that allows a thing to move and circulate with legitimacy, and that make authenticity communicable and interoperable across infrastructures and systems. Assuming that machines assess authenticity with more reliability and accuracy means that covert authentication devices have come to surpass human perception and arbitration, invoking a machinic and automated processing of what and who is real.²² When authentication devices contribute to a material environment rich in information potentially unreadable to the human senses, they also inevitably reproduce and multiply the opacities of the infrastructures they are working to legitimately protect (Black, 2014; Greengard, 2015; Kùchler, 2008).

This time-space data tells the story of the authentic specimen in terms of what anthropologists have called an object’s itinerary. While the notion of an object biography focuses on ‘life and death’ as a linear sequence that moves from birth to disintegration, the complementary concept of the object itinerary focuses on ‘the strings of places where objects come to rest or are active, the routes through which things circulate, and the means by which they are moved’ (Joyce and Gillespie, 2015: 3). Indeed, in the case of tracking devices in particular, there is an ontological relationship between the ability to demonstrate pedigree (where has the object been?) and the assurance of authenticity (what is the identity and value of this object?). Pedigree can be understood as a collection of facts, and people too can be authenticated through such extrinsic and objective information, whether biometric or biographic, which, in the case of a definitive document like the passport, is confirmed through a process of matching a document to a database. Ultimately, if authenticity is constituted through a set of data,²³ devices are no longer just sensory and informational in their functions or effects, but are also connected and computational. In this ‘augmentation’, authentication shifts from being an overt mechanism that can be seen or touched (human-readable), to one where data is scanable, tracked, traceable, and encrypted (machine-readable). Computational authentication thus becomes the result of an automated detection and connection. In this process, devices perform their duties by making links so that authentication and authenticity move from being located in the thing to being produced and performed through the networks and relations between things.²⁴

Multi-functional authentication devices are thus one example of how a specific application is moving computation into the environment (Hayles, 2013: 504), activating and connecting things to communication and information infrastructures in the name of security. Infrastructure here is better understood as a ‘fundamentally relational concept’ rather than as a ‘concrete object’ (Parks and Starosielski, 2015: 9; Star and Ruhleder, 1996). In such infrastructural systems, paper and its authentication devices perform an important role as credible documents that assure that things and connections are secure, legitimate, and authoritative. Thinking these devices in this way is not purely or ‘merely’ materialist: these are the sensible, informational, and computational qualities that protect authentic paper so that it can circulate and move across space and time. Authentication devices are in this way a reminder of the logistics at play in infrastructures of mobility: they are the ones doing the work.

Trusting Devices in Infrastructural Work

If we think about technologies like optical devices, audio devices, recording devices, and of course mobile devices, we quickly realize how ubiquitously the term device is used in describing the plethora of artefacts that constitute the media landscape. When referring to a technology in a generic sense, it is often simply a device *for something* (a pen becomes a writing device, an engine a powering device, etc.). Not unlike a tool or instrument (or even a contraption or thingamajig), the device is something with a technical utility, part of the constellation of concepts and words used to name, describe, and categorize the technical universe, able to be ‘applied interchangeably to materials, objects, technologies or stuff; (Amicelle et al., 2015). Often calling something [blank] device is useful when it doesn’t yet have its own name, which speaks to the device as being a ‘moment’ when uses or applications are still being negotiated, and when technology is still malleable. Conversely, in the case of the mobile device, we have witnessed a retreat from the specific – a mobile phone or cellular phone as a device for transmitting sound and for talking – to the non-specificity of versatility. This is because now this device allows us to do a whole host of things other than talking: search for information, send text and multimedia messages, take pictures and record sound and video, count, organize, track, geolocate, etc. This is a ‘phone’ decked out with functions, so much so that it has come to be referred to primarily through its mobility – mobile device (functions on the move) – rather than by the many specific things we do with it.²⁵ Either way, we know from this example that one of the central ways we understand the device is as much wedded to or defined through its function or the way it functions. What we might ask ourselves then is

when and how the device becomes fixed through the functions that it performs, or when it becomes a device for *this* rather than for *that*.

This is part of the question of what constitutes a device. In Latin, device is found in the notion of division (*divider*), while early usage in the Middle Ages – first in Old French (*devis*) followed by Middle English – led to a multiplication of meanings: wish and desire, drawings and designs, plans and schemes (*Oxford Dictionary*). The at once specific and flexible nature of the term has remained since these indiscriminate beginnings. A recent definition proposes that ‘a device is an artefact, a piece of equipment or an instrument made or adapted for a particular purpose, as well as a plan, method, trick or intrigue, and finally a design or motif. To use the notion of the device is therefore to call for the simultaneous consideration of object, purpose and effect’ (Amicelle et al., 2015: 294). This useful definition reflects the dual quality of the device: that it is a physical artefact, but also that it has an existence in various technical contexts that are not technological, for example in the case of writers who use literary devices to craft their stories, or when storytellers draw on mnemonic devices to prompt their memory. In this sense, there is a connotation of the clever, witty, or even deceiving ways that devices work to achieve certain goals, purposes, and effects. This helps explain the ‘magic’ they perform in transforming paper from cheap to valuable, from the generic or illegitimate into the authentic.

Across these various meanings of the term device, one recurring way that it has been used is to describe techniques of authentication. For example, the coat of arms and the emblem were types of artwork and ornament that were understood as devices. As heraldic devices, they represent, identify, stand for, and legitimate affiliations, whether of an individual, a family, an organization, or a state. They are markers that clearly indicate not individuality but belonging. A heraldic device is thus a visual seal that communicates allegiance, signifying and legitimating the provenance of their bearer. In the same way as do stamps or watermarks, or any host of other devices that act as authoritative representations and reproductions, they must be visibly recognizable as authentic in their own right. These images are more than decorative pictures, whimsical features, elements, or representations: through their legitimacy they provide and guarantee authenticity, the assurance of dealing with friend rather than enemy. Only by understanding this powerful functional role of the authentication device can we understand their intrinsic value as technologies at work.

One of the few theorizations of technology centered around an idea of the device is Albert Borgmann’s use of the term in *Technology and the Character of Contemporary Life* (1984). In this work he proposes his famous, if contested, ‘device paradigm’, and considers the function of modern technology as being solely a means to an end, with technologies becoming opaque commodities, both increasingly easy to use and harder

to understand. Through this essentialist framework of means and ends, the device paradigm addresses questions of the ‘impact’ and influence of technology in relation to our engagement with reality. Borgmann’s project is *not*, however, to situate or compare the device vis-à-vis other concepts or technologies, but rather, in taking the concept for granted, he places it in relation to what he calls pre-technological practices and things. In Borgmann’s warning, technology *becomes* ‘mere’ device when it is reduced to a function. In this work there is a generalized notion of device as part of his philosophy of technology, but in large measure the device paradigm is itself an example of the under-theorization of the concept of the device, as a term that ‘merely’ reflects a self-evident function. Andrew Feenberg’s constructionist retort to Borgmann’s device paradigm is to note that technologies are part of larger social, aesthetic, political systems. In other words, where Borgmann argues from an essentialist view that the primary attribute of technical artifacts is their function, Feenberg suggests that devices are social and that their ‘function is just as social as the rest’ (2000: 305), so that objects are things and become technical devices only when a function is assigned to them. This debate resurfaces here: at which point does a device characterized by its technical function (optical, haptic, etc.) become ‘transformed’, ‘fixed’ and socially integrated into a device defined through and trusted to perform as part of a system (of mobility, authentication, security, etc.)? To understand how the authentication device becomes such a technical and political mediator of security is thus to ask both ‘How does a device work?’ but also, ‘What are the rules and assumptions that enable these devices to effectively be used, function, and “work” as part of larger systems and infrastructures?’ (or, who is the device working *for*)?²⁶

This enfolding of technique and social work which devices perform surfaces strongly in other languages. In French, for example, which does not have a direct equivalent to device, multiple words are used, depending on context, – terms like *appareil* and *dispositif*, that complicate the idea of function and the movement between things, relations, and systems, between the material, institutional, and infrastructural. It becomes apparent, then, that the device and the work it performs is more political than it first appears. A speeding gun is a device for monitoring speed (monitoring device), but also for enacting and enforcing the law (legal device). How the device works and what it does is continuously pivoting and shifting from one register to another, tricking and deceiving in the way that devices can do, being and becoming in a world of concerns, not immutable facts. There is, therefore, a negotiation between the technical and social dimensions of a device:

On the one hand, each device is related to a particular history; it is based on negotiated standards, finalities and functionalities that

convey specific representations of the sociopolitical issue(s) at stake. [...] On the other hand, security devices are not static: their force of action also depends on processes of production, translation, circulation, appropriation, experimentation or resistance. (Amicelle et al., 2015: 294)²⁷

Specifically, by doing the work of comparing the device to other concepts of technology such as *dispositif* and assemblage, Anthony Amicelle, Claudia Arandau and Julien Jeandesboz describe three ways that an ‘analytics of devices’ is different: it is less interested in ‘epochal renderings of security’; it moves understandings of technology beyond debates on instrumentality or autonomous social force; and it ‘recasts recent discussions on “materiality” in international and security studies by extending the attention to “things” to the arrays of equipment and instrumentation through which security is performed’ (2015: 295). Holographs, for instance, are the ubiquitous iridescent feature used on banknotes and passports (as well as credit cards, apparel, and a whole collection of goods) to communicate with us through a particular optical effect that this is the real thing. Used in this way, the holograph sticker is an authentication device. At the level of science and technique, however, holographs are defined as optical variable devices (OVDs). When classified as an OVD, the holograph is placed within a class of technologies that describes not its application – authentication – but its technical effect – optical variability. As the context of the device shifts, the holograph becomes defined and fixed through different categories, applications and discourses, so that the relation between these pivots around this central question: a device *for what?* This is a good example of how a device’s function or application paints a technology in different colors so that, as Susan Leigh Star has noted, ‘we see and name things differently under different infrastructural regimes’ (1999: 380), or what Arjun Appadurai has described as different *regimes of value* (1996: 4; emphasis in original). In the case of the holograph, as it moves from being an optical device to an authenticating device it becomes defined by the way it is used, its value emerging from the way it is logistically integrated in the large-scale infrastructures in which things circulate.

As logistical media that assure and ‘secure’ authenticity, authentication devices act as trustworthy intermediaries, but they also become inextricable from the tentacular material apparatuses of mobility infrastructures and the rules and protocols they set in place. While security is ‘usually defined in military terms to refer to national security’ (Zureik and Hindle, 2004: 114), authentication devices act out a broader idea of security as ‘protecting and defending’ the mobility of bodies and things across borders and systems by legitimating, authorizing, and making official. The various authenticating elements on official papers

are therefore not ‘innocent’ decorative features but functional logistical devices that contribute to the smooth and secure everyday operation and reassertion of global flows, helping to coordinate and synchronize the many scales of infrastructural work. They make possible the moments of verification and clearance along the routes of migration, trade, and other formal paths of exchange and ‘the management of circulation’ (Salter, 2015: ix). In these infrastructural ‘chokepoints’ (Limn, 2018) – which, in the language of the object itinerary become obstacles, stoppages, knots or nodes²⁸ – authenticated matters are accepted, approved, and deemed trustworthy and secure for further progression, the individual thing allowed to be part of the greater regulated whole (e.g. money has value because someone else accepts it). In this important moment of confirming the legitimacy to move, authentication devices thus become ‘agents of security’ that, through their form and function, ‘link to and reinforce the goals of security in any given context’ (Grondin and Shah, 2016: 92–3.) They are crucial in the gateway moments that open up further circuits and trajectories; indeed infrastructures break down if we cannot trust the legitimacy of the people and things on the move.

To understand the workings of authentication devices infrastructure becomes not just a physical network, or ‘matter that enables the movement of other matter’ (Larkin, 2013: 329), but a collection of protocols regarding logistics, standards, and quality control (Cowen, 2014; Easterling, 2016). Only then do the authentication devices make sense as an interface between the things and systems. They are an articulation of ‘the profoundly political life of forms of knowledge and calculation that present themselves as purely technical’ (Cowen, 2014: 4), and an example of the aesthetic, or ‘poetic’ (Larkin, 2013), dimension of infrastructures of mobility and of mobile infrastructures (as Jordan Frith notes of RFID, 2019). As Keller Easterling puts it, this is a ‘classic’ example of ‘the medium is the message’: ‘what the medium is saying sometimes prevents us from seeing what the medium is doing’ (2016: 13).²⁹ As art historian Jennifer Roberts argues: it is the ornament that is doing ‘the tough economic work of paper currency’ so that ‘without ornament, these notes simply would not be able to move’ (2016: 308). Put differently, as does one security printer: ‘As with anything that is designed well, it’s not just about creating an eye-catching look but matching aesthetics with functionality’ (De La Rue, 2011: 16). Indeed, authentication is an active process that requires literacy (of human or machine) developed through a shared recognition of the qualities, values, and meanings of authenticity: the argument after all is not that valuable paper is only materially-defined and operates outside the logics of representation or discourse, but rather that the security devices of such papers have intrinsic value that distinguishes them from vast swathes of ‘cheap’ paper that could never successfully do the work of ‘standing in for’.

Conclusion

Recently, a typo was discovered on an Australian banknote, with an ‘i’ missing in the word ‘responsibility’ printed in micro-text on the bill. First released in October 2018, the bank became aware of the error two months later, while it took until May 2019 for the public at large to pick up on it. A spokesperson made the following remark: ‘These banknotes are legal tender and can continue to be used as normal. It does not affect their validity and functionality in any way’ (CBC, 2019). Other than confirming that banknotes are not usually read for the information they contain but rather treated as a sensory artefact – i.e. the banknote could still do its work despite the typo – it is also an example of how infrastructures and the work they do tend to remain invisible until there is a breakdown, rupture, or failure (Easterling, 2016; Starosielski, 2015; Starr, 1999; Starr and Ruhleder, 1996). In this case, the typo is the moment of visibility that confirms how little attention is usually given to reading infrastructural mobiles like banknotes. Meanwhile, that these notes could still circulate and be trusted confirms the material and aesthetic value provided by the devices at work.

Valuable papers are media that function as official and genuine documents, but they can only function in this way if they are trusted. Trusting paper requires the work of authentication devices, which provide paper with an intrinsic value that distinguishes it from a poor-quality imitation. The politics of these devices lies in their technicity at the intersections and interactions of infrastructures, mobility, and logistics, or the supporting and enabling material systems and structures that constitute the interlinked technologies and practices of security. As logistical mediators of legitimacy, authentication devices thus allow papers to connect and circulate as part of infrastructural space: they are ‘major parts of the back-end that make our world work’ (Frith, 2019: 33). They mediate authority by ordering and sorting, and they can never be presumed to be innocent and independent from the relations and realities they support. In the adaptation, conflation, or grafting of technical functionality and what could be described as a device’s role or performance – in the infrastructure of a system, an ecology, a structure, a network, an apparatus, an ideology – the matter of how one is fixed onto the other matters. This relational dependence can be clarified by looking into the processes and political economies of innovation as the device shifts from technical device to functional device, from the scientific lab and the realm of technical discourse into the security industry, and the secrecy it requires to perform its work. At stake might be how to control the techniques used for authentication, or how to define or limit the devices, workings, rhetoric, and performance of ‘security’.

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Notes

1. It should be noted that in China, paper currency was already used in the 7th century (Kurlansky, 2016).
2. The language of magic surrounded paper money in these early days. Weatherford notes the example of Goethe's *Faust*, in which printed money is described as a kind of alchemy (1997: 139).
3. In this passage Emily Gilbert is specifically writing about money, adapted to include ID documents.
4. 'Paper' is used throughout in a general sense to refer to both an organic cellulose-based substrate and to modern variations that use polymers.
5. Understanding media in terms of their biographies helps us 'make sense' of the way their narratives are crystallized (Natale, 2016). Here, for example, paper money is born only because of a restructuring of our material and discursive relationship to paper.
6. See Aleksandra Kaminska (2019) for a discussion on the ways that security printing provides an alternate history of printing not based on an expansion of access and dissemination of knowledge.
7. See Lisa Gitelman (2014) on the 'know-show' function of documents.
8. The question of realness is not anchored here in a philosophical debate about the nature of the real, but as a material standard that contributes to the ordering, classifying, and categorizing of the world of things. It is also beyond the scope of this paper to delve into the 'ambiguous and elusive ideal' of authenticity (Lowenthal, 1992: 80). However, it can be noted that it is a socio-cultural value constructed as an extension of the profound 'distrust of the "fake" and reverence for the "real" and "authentic"' that 'seems to be deeply ingrained in human nature' (Ball, 2016).
9. The precise value of silver and gold is not a given either, since it is itself the product of economic trends and markets. Indeed, whichever form it takes, 'money is one of the most important *inventions* of human history' (Robert Gordon in Carruthers and Babb, 1996: 1558; emphasis added).
10. According to book historian David McKitterick, rarity is not just the result of scarcity but also of physical features which 'could be of sometimes overriding importance in discussion of what was to be singled out as worthy of especial attention' (2018: 63). In other words, we can consider quality not quantity (i.e. scarcity) as giving the printed object its value.
11. One of the critiques of Simmel's account of money is that he was unable to adequately deal with this problem of the value of money and that money 'must also in its very essence itself be an object of value' (Bottomore and Frisby, 2011: 12).
12. Because paper was part of everyday life, security printers had to start there when making their distinctive notes. Their success meant that, in the 18th century, paper was perceived as 'one of the most difficult elements... to imitate' (Mockford, 2014: 132). This is in part because of techniques like marbling and watermarking, and limitations like access to the right mills. There was also tight security around the making of the paper substrate. In

England, molds for the paper were kept for safekeeping at the Bank and sent to the paper mill only as required, with a Bank 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).

13. Of course, not everyone had the right tools or know-how, but they were not rare or unattainable.
14. A close reading of security printing marketing materials indeed reveals the scale of their investment into R&D, and the importance of presenting their technology as perpetually cutting-edge (Kaminska, 2019).
15. As opposed to thinking of paper notes in terms of their 'archaicism' (Brunton, 2019: 22) or as 'old-school, analog document security' (p. 53).
16. Rudolf Van Renesse notes the distinction between devices that work because they can be confirmed as false (negative evidence, or 'falsifiers') and those that work because they necessarily confirm genuineness (positive evidence, or 'verifiers') (2000: 92).
17. See David Grondin and Nishah Shah (2016) for a discussion of secrets as an instrument of security.
18. Those that can do both overt and covert work can be called converging devices, while a fourth category refers to forensic devices. These are devices that allow for authentication after the fact, such as the way that analyzing the paints used in a painting can provide information on the chemical make-up of the pigment and thus help authenticate the object. Forensic devices were not designed to act as authentication devices, but function as so because they help to date and locate the origins of materials.
19. For a detailed discussion on the spatial and temporal qualities of authentication devices see Aleksandra Kaminska (2018).
20. Passports have that peculiar role of having to both authenticate themselves while also creating a secure link to the person they are working to identify.
21. See Craig Robertson's work on the transformation of identity into facts (2012, 2014, 2015).
22. It is worth noting that there is, despite this automatization, still a need for human interpretation, for instance to evaluate the cases of false-positives or negative-matching, which requires that a human analyst interprets a data image.
23. A relationship that is often understood as unequivocal: 'Data allow your political judgements to be based on fact, to the extent that numbers describe realities' (Hans Rosling in De La Rue, 2017: 12).
24. See also, for example, Brian Larkin's discussion of infrastructures and the relationship between things and their operation as systems (2013: 329).
25. Interestingly, a search on Google Ngram reveals that use of the word 'device' prevailed over 'technology' and 'media' until 1969 and 1971, respectively, precisely around the time the inventions of the integrated circuit and single-chip microprocessor transformed the design of computers and allowed for the proliferation of multi-functional portable electronic devices. This linguistic reversal could be a reflection of shifting attitudes about the things we make, one that became more open to the possibility that things exist in ways uncontained by and beyond the description of their technical functions.
26. This questioning is an adaptation from Craig Robertson's (2014) work on paper.

27. Amicelle, Arandau and Jeandesboz (2015) compare the device to notions of technology, dispositif and assemblage.
28. Rosemary Joyce and Susan Gillespie (2015), in reference to the work of Susanne K uchler.
29. On this point, in a Bank of England (n.d.) informational booklet, all of the security features presented have to do with how information is presented, not with what information is included.

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