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New Inventions for Personalization and Security for Printed Documents

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NOTE: Due to the limitations of electronic document transmission, the high-resolution details of actual printed specimens cannot be accurately depicted. Please contact the author for hard-copy examples of the technologies discussed herein.

Pixels and Paper

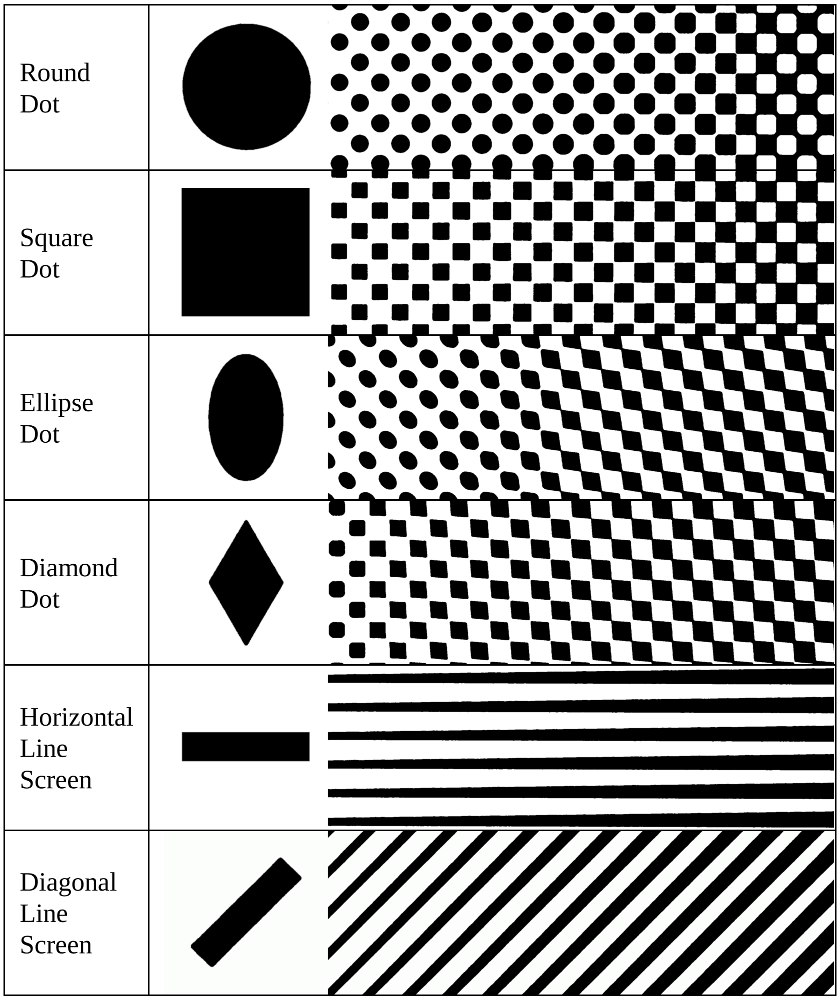
The building-block of digital imaging is the pixel. Pixels are those tiny points of light that you see on your computer display when you examine it with a magnifying glass. On color displays, carefully focused pixels are arranged in red, green, and blue clusters to simulate various hues that are modulated in brightness to approximate color intensities. Laser printers apply a charge to a magnetic recording surface with a sweeping beam that flashes at the center points of pixels. Scanning machines reverse the action of the pixel to “read” an image through a moving array of sensors. Pixels are the smallest addressable element under the control of the device. The spacing of these pixels is referred to as the resolution of the display, scanner or printer.

Within the printing industry, device pixels are truly microscopic. Imagesetting machines we use to make printing plates employ pixels that are approximately 1/2500 of an inch (or smaller) in size. Compared to a standard computer display, these machines have as much as 30 times more pixel resolution. Although computer displays cannot accommodate images at these resolutions, regular printing plates and paper handle them well. Hundreds of pixels are typically illuminated together to create a halftone dot. For instance, a single halftone dot used in standard 133-line commercial printing is constructed from 366 (or more) individual pixels. Based of the virtues of offset halftone printing, a new technique has been developed that exploits paper’s exceptional resolution-holding potential. With Amgraf’s LogoDot™, the halftone dot itself is being commercialized and used to store microscopic images. And once printed on paper, these images cannot be accurately copied.

Conventional Halftone Technology

Halftone screening dots have been in use for years to enable the printing of continuous tone images. To print various tones of color on paper with printing presses and ink or toner, the area of color must be converted to halftone dots (or lines) of an appropriate radius or thickness, with the (normally white) base paper (or other substrate) color showing through. Close examination of almost any commercially printed document will reveal these halftone dots. The inventors of halftone screening have strived to develop methods to generate halftone dots that are free from artifacts, and that render printed images which are as faithful as possible to the original continuous tone (unscreened) models, and do so under the most extreme printing environments on the widest range of substrates. Typically, conventional halftone dots are shaped as solid squares, filled circles or ellipses, filled diamond shapes, and/or solid lines, and they are used to print everything from newspapers and magazines to elaborate security documents such as checks and certificates.

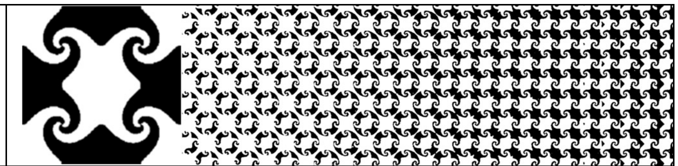
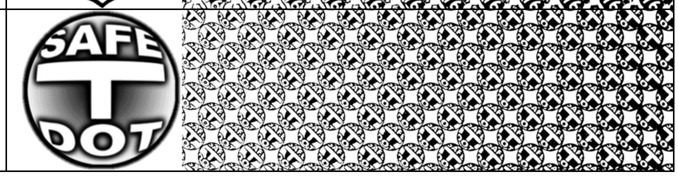
Halftone dots are successful in visually representing tones and images on a printed object because the human eye merges the dots into a perceived continuous tone. This occurs because the dots are typically very small, and only obvious if the printed document or object is enlarged or magnified.



Examples of Conventional Halftone Dots

LogoDot Technology

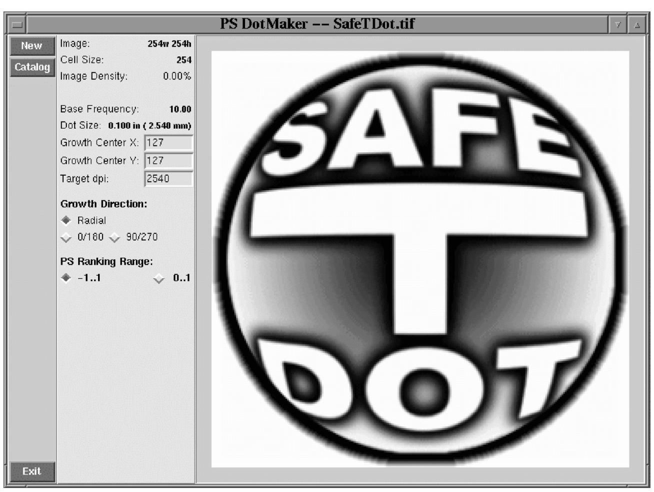
Called LogoDot, Amgraf's patent pending invention describes a method to capture any user-selected image such as a corporate logo, a photograph, or a key word or phrase, and to convert that image into a microscopic halftone dot with tonal variation features, and to allow the use of these custom dots as a substitute for the conventional square, round, elliptical, diamond and/or other shaped dots typically used in normal commercial printing. Through this invention, all or selected areas of a printed image can be rendered in LogoDots that can be verified with a magnifying device. The ability to include one's corporate logo or self-portrait as a repetitive microscopic image within a printed document or object has the appeal of extreme personalization as well as providing original document validation.

Shape Dot	
Photo Dot	
Symbol Dot	
Phrase Dot	

Examples of Custom Halftone Dots

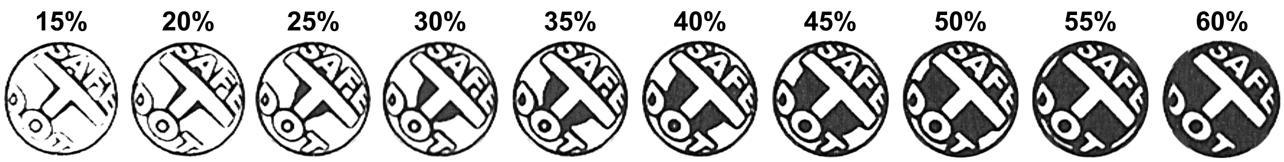
Capture Any Image

The dot designer captures a "seed" image to use as the LogoDot. The image can be scanned from a hard-copy of the image or obtained via a digital camera or other means. The image then is reduced to a rectangular "bit-map" with an overall pixel count not to exceed 255 x 255 pixels. Using standard desktop publishing pixel editing software, the bit-map is edited to indicate the preference for progressive illumination of the pixels from white to black, by making the most prominent pixels black, the least prominent pixels white, and the order of tonal variation across the dark to light spectrum in various shades of gray. The resultant "seed" image is saved from the pixel editor program then loaded into Amgraf's DotMaker program, named, and processed into a LogoDot consisting of illumination ranking instructions. These coded instructions are then stored in a Custom Dot Library and can be utilized with PostScript imaging devices to create printing plates, negatives, and/or films that contain the LogoDots.

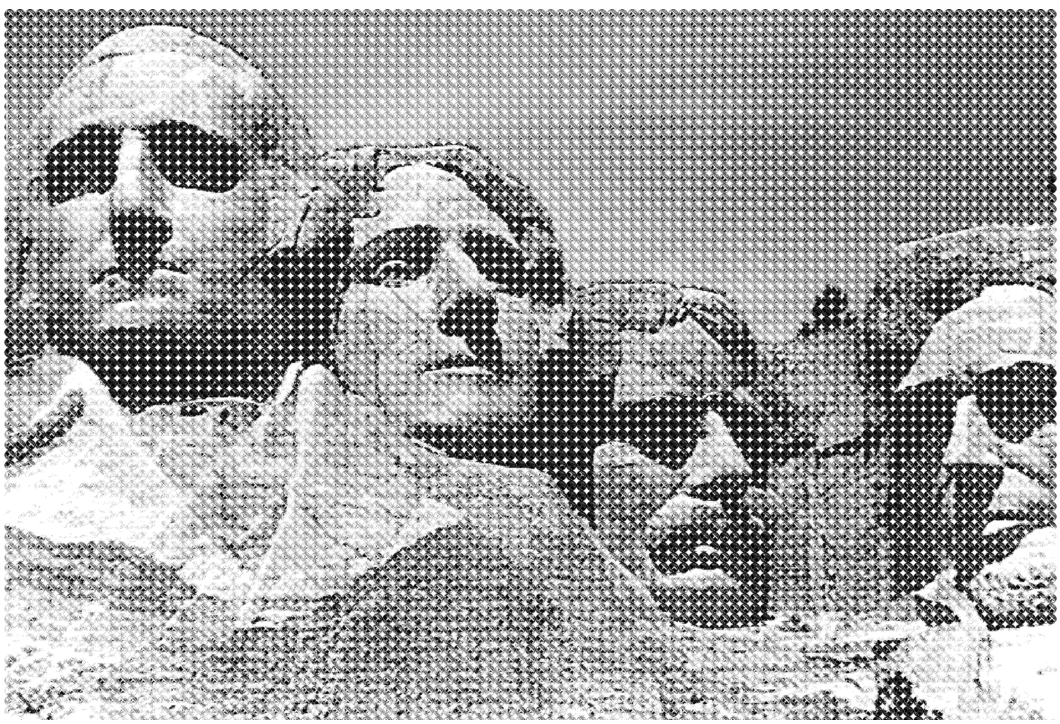


The DotMaker User Interface

Like conventional halftone dots, LogoDots automatically adjust their tonal density from white-to-black, and all variations of gray level between black and white, dynamically according to the attributes of the graphical element or the wishes of the graphical designer. The microscopic images are inserted during the document's or printed object's creation and/or composition. Because all other aspects of the document's production are unaffected, LogoDots provide an economical means to create and print highly personalized documents. LogoDots can be used in combination with conventional halftone dots for rendering any graphical object, e.g.. photographs, raster images, logos, symbols, text and typefaces, rules and lines, circles, arcs, splines, colored areas, borders, pantographs, patterns, and any other graphical element found or used in a commercially printed document.

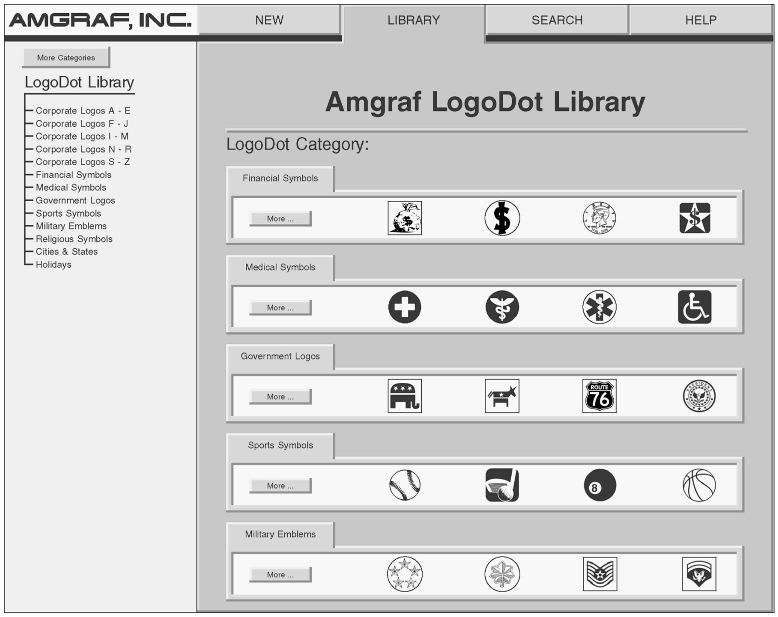


Preview the dot image as the density progresses from 0% (white) to 100% (black)



Photographs and other Graphical Elements can be Rendered with LogoDots

Included in the technology is a simple method to name each custom dot design and refer to the custom dot by name when linking it to a graphical element within a composite image. The inventor also has developed a system to build and catalog libraries of custom dot designs.



Custom LogoDot Designs are Maintained in Libraries

The Ideal Graphical Security Feature

One of the first applications of LogoDots are for the manufacture of printed security documents.

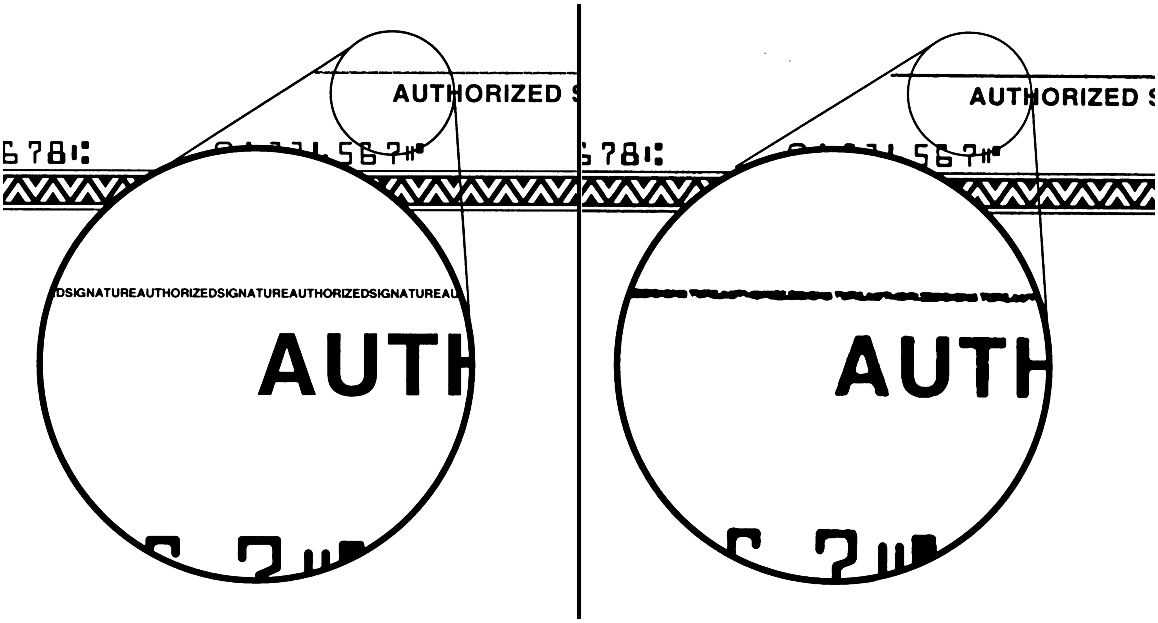
Desktop publishing systems with low-cost scanners and color printers have made it easy for criminals to counterfeit all but the most secure documents. In addition, photocopying equipment has improved, especially in the case of color copiers, and the many “void” pantographs are no longer reliable. New color copiers compensate for subtle tonal variations with remarkable results, producing near-perfect copies that cannot easily be identified as copies.

Documents that contain LogoDots have a magnifying glass symbol that shows an enlarged image of the custom halftone dot utilized within the document. Since the LogoDot does not photocopy, a quick check with a magnifier will reveal if the document is an original. Not only does the LogoDot fail to photocopy, it tends to degrade and spoil the appearance of the document.

The ideal graphical security document feature is something that is commercially simple to print yet difficult to copy, and usable as a non-intrusive background image on an original that subsequently interferes with the document’s legibility on the copy. The perfect security document is easily verified and provides a high level of confidence in its authenticity. The LogoDot technology has the potential to offer these benefits.

Good Original – Bad Copy

To help understand the copy-resistant phenomenon that is occurring, consider the widely used graphical security technique known as “microtext”. With microtext, words or phrases are printed in very small letterforms that can barely be perceived with the naked eye. These tiny letters are too small to be accurately copied by most of the available scanners and photocopiers. The resulting copy yields a "blot" instead of a legible letterform, and a string of letters or words often copy as a fuzzy line. Similarly, LogoDots are micro-images that darken and distort during the copying or scanning process.



Microtext Before and After Being Photocopied

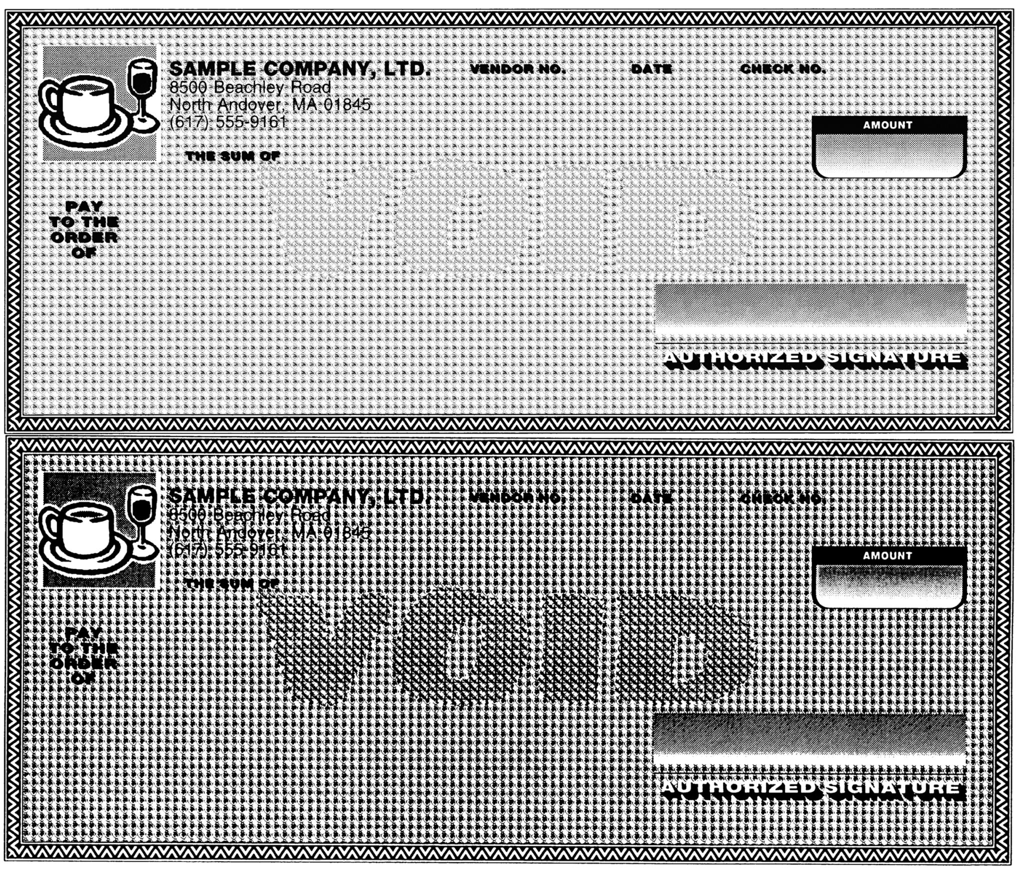
For further protection, LogoDots of different micro-images can be composed together to create hidden messages or symbols. When a copy is made, different LogoDots degrade at different rates, which results in a pronounced visual disparity in the copy. A mixture of LogoDots and standard halftone dots can also be used together within a composite image, and when their densities are set to similar gray levels, the human visual perception blends them together and gives the illusion of a uniform density spread. However, when sampled (seen) by a photocopier or scanner, the custom dots "pop out" resulting in a lighter or darker gray (or color) value being rendered. Much of the darkening effect is due to toner trapping within the microscopic details of the embedded LogoDot images.

LogoDot Used as a Check Background. (Magnified Area shown on Next Page)

Another reason that the LogoDots do not precisely photocopy or scan is due to the unique arrangement of the pixels that make up the microscopic image within the LogoDot. For a given tonal density (e.g. 40%), the same number of pixels within a custom halftone LogoDot cell are illuminated (set to black) as for a conventional 40% halftone dot cell. Although the pixel count is the same, the fact that the pixels are arranged into a non-conventional microscopic image causes the LogoDot to have reflective and/or transmissive properties that are slightly different than the reflective and/or transmissive properties of conventional halftone (e.g. round) dots.

Original and Copy of LogoDot Check Background

For these reasons, LogoDots provide a unique way to embed hidden warnings, phrases, images, logos or other graphical elements to self-cancel the counterfeit copy. When combined with other graphical features such as relief lines, guilloche patterns, phantom images, and warning bands, cost-effective graphical security can be added to almost any printed document.



LogoDots can be used for Self-Canceling Document Backgrounds (Top is Original, Bottom is Copy)

Nanostructures and Other Emerging Technologies

For the highest level of graphical document security, extremely minute encrypted nano characters and other geometric structures can be printed in a specific pattern configured for forming an anti-copy latent warning message, which appears when copied. These nanostructures, invented by Verify First Technologies and marketed as NaNOcopy™, comprise a message that is printed in such a way so as to take advantage of the limitations of digital optical scanning systems and toner or ink jet output The nano technology printing is latent to the casual first line visual inspection, but the visual density disparity between the nano printing pattern and other printed background exhibited on the copied document is effected by the darkening of the nano configured warning message when copied. Additionally, the nano structures can be uniquely printed to formulate certain encrypted information or an algorithm calculation for further verification and protection from counterfeiting or alteration. This information can be in the form of numbers, words, or combined with LogoDots to, in effect, embody a separate message, such as indicia indicating validity, date printed, customer name, and/or secret numerical code, within the latent warning message.

There are many non-graphical solutions to incorporate security into a printed document. However, these usually contribute substantial added expense to the manufacturing process. Some of the most common protective techniques are to use special inks (e.g. fluorescent), special papers (e.g. embedded filaments), chemical additives (e.g. magnetic or thermochromic reactive coatings), affixed devices (e.g. holograms), pre-treatments such as watermarks, and post treatments such as embossing. While there are compelling reasons to utilize many of these techniques, the addition of security features via purely graphical methods can be done much more economically, without a major change in the traditional print manufacturing processes. Although non-graphical security techniques and devices may be suitable for the particular purpose to which they address, they are not economical for manufacturing the broadest spectrum of highly personalized and protected documents.

For strong document security, layers of graphical and non-graphical features need to be employed. Appleton Security Products, in partnership with Spectra Systems, has recently developed the Pocket Eye™ handheld reader that can detect the combination of a substrate embedded UV coded taggant with the presence of other data such as a digital watermark. The UV coded taggants, trademarked TechMark™, are embedded into the substrate and are covertly coded so only the Pocket Eye™ reader can identify them. Unless the reader identifies the presence of the TechMark code, the data carrier cannot be opened. In conjunction with NaNOcopy and LogoDot, a digital watermark, a data glyph, RF chips or bar codes, TechMark acts as the key in a lock and key system. This combination creates an incredibly strong document security system.

In this scenario, even the best criminal minds would have difficulty reverse engineering the three combinations of elements to replicate the encrypted NaNOcopy/LogoDot - the UV coded TechMark taggants and the digital watermark. The Pocket Eye reader could read all, or combinations of the three, offering maximum protection, before it would open or verify the document's authenticity.

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