



Engraving

Most people see and use paper money every day of their lives without realizing the great skill and individual artistry that goes into the engraving of U.S. currency.

Banknote engraving is a complex and intricate intaglio art. The engravers at the Bureau of Engraving and Printing have displayed artistic talent throughout their lives and have studied their craft for many, many years; they are the masters of the delicate carvings and etchings that we see every day on our paper currency.

An engraving is a series of lines, dashes and dots, combined together in the "banknote style," which forms a complete picture such as a person or landscape. The original design for currency may be a drawing, painting, or photograph prepared in an enlarged size by a banknote designer. This includes requirements for quality, detail, and counterfeit deterrent techniques. The designer's art is photographically reduced to the desired size to become the model for the engraver to interpret into the engraving. The engraver scribes an accurate line tracing of the model on to acetate, defining size, shape and tonal range, light to dark, all aspects to help impart a visual life to the engraving.

When the drawing is completed, the engraver makes a hard wax transfer by rolling a ball of wax over the scribed acetate, coating its surface with a thin film. The acetate is then carefully positioned onto a highly polished steel die, wax side down. When a burnisher is rubbed over the acetate, the engraver's tracing, in wax, is transferred to the die. A weak solution of acid is put over the die giving a light stain of the traced image. This stained outline serves as a guide for the engraver to cut into the die.

The actual engraving of the die recreates with hand cutting and etching the entire picture, as originally modeled, formed in the dots and dashes characteristic of the banknote engraving technique. The disciplined lines and dots go in many directions and may be of varying depth, width, and spacing. It is the artistic judgment of the engraver to create a disciplined and complex image, which provides a detailed precise rendering, an illusion of three dimensional reality printed to the two dimensional surface of the paper. In printing, the incised or etched intaglio lines hold ink while the surface of the plate is polished clean. The ink in the image transfers to the paper under controlled pressure giving us the raised intaglio print. This skill of creating visual life, integrated into fine and bold line and dot structure provides the wide range of image quality which is difficult to reproduce and therefore difficult to counterfeit.

An engraver must have extensive knowledge of the art, patience to endure the tedious execution of engraving, and the manual dexterity necessary to hand cut precise, minute details, such as those found in portraits, vignettes, and borders. One example of the precision found in the BEP's engravings can be illustrated in the following true anecdote:

The BEP offers, among many other miscellaneous products, engraved portraits of all the United States presidents. When Franklin D. Roosevelt was elected to office, one of the BEP's top engravers, John Eissler, was assigned to engrave the President's portrait.

When the engraved portrait was completed, a print was sent to the White House for approval. A few days later, the BEP received a call from the White House saying that the President wished to meet with Mr. Eissler. Everyone at

the BEP was elated; they were sure the President was delighted with portrait and was going to lavish praise upon Mr. Eissler for his superb engraving.

Excited and not just a little anxious, Mr. Eissler arrived at the White House. The President invited him to sit down and said, I realize, Mr. Eissler that you are a very fine engraver and this portrait is splendid. But do you really think it was necessary to put that wart on my nose? Needless to say, the wart was removed.

That anecdote illustrates the precision required of the engraving art.

Engraving apprentices are hired on the strength of their drawing talent and are taught their specialized art and skills from the master engravers employed at the BEP. The apprenticeship for a Picture Engraver is 10 years; a Letter and Script Engraver, seven years.

The engravers instruct their apprentices in all facets of their craft; all work is inspected as the apprentices are prepared for their chosen profession. Years ago, the method of training for apprentices included requiring them to draw, in pencil, exactly what the finished engraving would look like, line for line and dot for dot. This preliminary drawing reflected the precision and skill involved in the actual engraving. Today, apprentices are still required to make detailed drawings as well as re-engrave existing portraits and vignettes into steel. This way, they learn very quickly what techniques to use (or not to use) to achieve a desired effect.

Tools of Engraving

The tools of engraving are very basic, having changed little over the centuries -testimony to the exceptional skill of the engravers. Most are hand-held tools that are made by the engravers themselves to be almost an extension of their hand.

The most important tools for an engraver are the graver, the burnisher, and engraver's lens. A graver is a hand-size hardened steel tool shaped to a sharp point. Gravers come in different sizes and shapes; the point can be wide or slim, flat or pointed, depending upon which of many cuts the engraver wishes to accomplish. Basic shapes of a graver are square, lozenge (diamond-shaped), and flat (chisel-shaped).

The burnisher is a slim hardened steel instrument with a rounded point at the tip. It is used to polish the surface and correct scratches and nicks in the soft steel die by gently rubbing (burnishing). The quality of the surface relative to the cut lines is critical to the quality of the final print. The quality of the steel is also important. While the surface may be smooth, the graver is cutting below the surface. If there is debris (such as carbon deposits) below the surface, the graver will create a divot which then must be repaired with additional burnishing.

An engraver's lens is one of the most individually important tools of an engraver. This magnifying lens is about the size of an eyeglass lens. Engravers use several lenses to suit each need: some work requires an extremely powerful lens because the engraving is minute and detailed. Other work necessitates the use of both hands and in this case a "loupe" is used. A loupe is a lens with a curved metal wire attached that can fit snugly around an engraver's head, leaving his or her hands free to manipulate both the die itself and the tools.

A ruling "machine" is another engraving tool. This precision hand-operated device is used for etching the straight lines required by the engraver. A single straight line like those we see on the outside border of our currency notes and the cross ruled lines that form the background of the portrait are engraved using this ruling machine. The portrait of George Washington on the \$1 note demonstrates a perfect example of combining the hand engraved line work and the

mechanical background tint in a banknote design. Each line was scribed through an acid proof "ground" one at a time. Since the "ground" of the die protects the polished surface of the steel die, the acid bites only into the exposed ruled lines, etching the precise and defined lines.

Both picture engraving and letter engraving require strong artistic talent and discipline, attention to detail and patience. After receiving a model of what is to be engraved, a picture engraver decides which tools, techniques, lines, and spacing are most suited to the job. The picture engraver interprets the direction of the lines, how many lines, and the depth and width of the lines. The engraver carefully plans each line of the engraving and does not begin to cut until this plan is correct. After the initial cuts are made, there follows a period of development where the subtle tone and shape relationships are strengthened, and progressive hand proofs are made until the engraving is completed. By contrast, a letter and script engraver has a rigid set of rules regarding the spacing of lines and curves. Engraved numerals and letters in banknotes have precise requirements that necessitate exact measurement; the tiniest of errors in letter, shape, and layout is very easily discerned.

Many of the traditional engraving skills and techniques remain unchanged since the engraving division's origin in 1862. Today, high speed presses demand special attention and techniques from the engraver when cutting the master die. Depth of line must be controlled, direction of ink wiping must be understood, all to obtain the highest quality of printing in the day-to-day of currency manufacturing. Additionally, new technologies related to note processing create more challenges to the engraver to ensure the art work remains aesthetically pleasing, but also capable of enduring the inspection process. As a result, engravers have expanded their tool box to include using specialized, digital engraving software and hardware to be able to address every line, dot, and dash to an exacting level as small as 1 micron (or 0.001 millimeter). Moreover, the technologies and capabilities within the digital engraving environment provide the engraver the ability to enhance an engraving by adjusting scale, complexity, and of course security, so that counterfeiting is even more difficult.

BEP engravers continue in the tradition and expertise of their predecessors: quality first and always. Today's engravers are now more involved with the whole design-to-print process so as to clearly understand the printing requirements. Consequently, the engraver can apply the necessary line widths, depths, cutting styles, and bottom treatments to all of the features within one environment in order to support print production of the currency.

As a result, the BEP exhibits the same excellent craftsmanship and unique artistry that has endured throughout its history, and continues to develop new techniques to create engravings and other security features necessary to deter counterfeiting.