Reviving the Art, Design and Technology of the Mid-1920s to Mid-1930s in Providence, Rhode Island, USA, to Manufacture Contemporary Filigree Jewelry

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Scrap Yard Story

I started working in the jewelry trade in 1987 under the guidance of several very talented goldsmiths and knowledgeable dealers who specialized in vintage and antique jewelry. Through practicing the art and science of restoring these antique pieces, I developed a great appreciation for the quality craftsmanship inherent in period pieces coming from first- and second-wave Industrial Age manufacturers of Providence, Rhode Island. I was regularly encountering sophisticated, solidly built, beautifully designed pieces of vintage jewelry. They set the standard for what I would regard as aspirational examples of the kind of work I wanted to do. Years later, I opened my own trade shop and, in 1993, visited Providence for the first time.

Providence revealed itself to me through a feature in the travel section of *The Washington Post*. Described as an important contributor to American culture, a foodie's delight and extremely friendly to tourists, it became that year's summer vacation destination. The article also mentioned the Providence Jewelry Museum and the Jewelry District, which were destined to influence my jewelry design and manufacturing sensibilities. With an interest in exploring some of Providence's historic Jewelry District (Figure 1), I ended up making a field trip to a dealer in factory-scale jewelry manufacturing machinery.

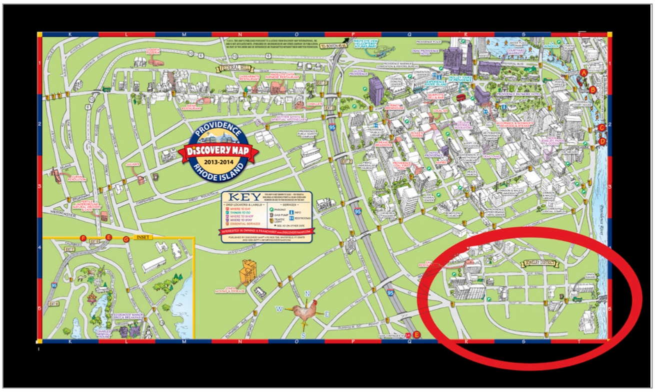

Figure 1 *Tourism map of Providence. Note the "jewelry district" at the lower right.*

I was rummaging around in this old warehouse complex when I noticed workers dumping broken boxes of steel parts into a dump truck to be sold for scrap metal. As they were loading, one of the boxes broke open and pieces spilled out on the ground. While I didn't have a true understanding of what I was looking at, I knew from experience that it contained very important jewelry designs. As the truck pulled away, I quickly excused myself and hopped in my car to speed after the dump truck. I finally flagged down the driver at a stoplight and convinced him to sell me some of the "scrap" on the back of the truck. Figure 2 shows some of the treasures rescued from that truck.

It took almost a year of researching and picking the brains of numerous folks in the jewelry industry before I started to fully understand what I had stumbled across and what it was used for: The pieces I had salvaged from the scrapyard were exquisitely crafted "hubs," actual size, three-dimensional, hand-engraved carvings of a piece of jewelry executed in tool steel. They were precursors to the actual tools that would be used to manufacture jewelry. Much of this work was created in the early 1800s.

Figure 2 *Some of the first hubs I discovered in Providence, 1993*

From this abrupt introduction to an unknown way of making jewelry came a series of ideas about how I could put together a sophisticated group of artisans in the perfect workshop populated with things I imagined were out there just waiting for me to find. More than 20 years later, I'm still at it.

Back then, I couldn't help but think about how I needed to intervene in any number of truckloads carting countless "mini-Michelangelos" to the scrapyard. I was hooked on the subject, fascinated by the workmanship, and determined to find and collect every loved and unloved treasure I could. Looking for hubs led to the discovery of countless other artistic treasures used in the Providence ornament and jewelry-design industry. A few hundred hubs led to thousands more hubs, dies and rolls (Figure 17). These treasures led to screw presses and drop hammers. These led to complete workstations and sometimes complete factories. For over 20 years, I've collected, catalogued and assembled whatever I could find that I felt would be useful in building a factory that could bring back into production not just great designs but the great quality of Providence's die-struck jewelry—especially the filigree pieces.

Anatomy of a Filigree Die Set

"T" shank #836, Waite Thresher Company

Figure 3 *Master hub and working die*

Figure 4 *Blanking/trimming tool*

Figure 5 *Piercing tools*

Figure 6 *Forming tool*

"O" Shank # 389, Waite Thresher Company

Figure 7 *Master hub and working die*

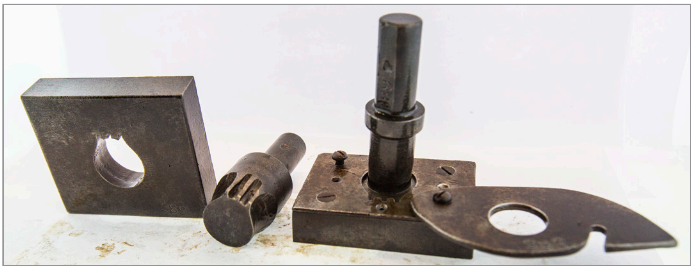

Figure 8 *Blanking/trimming tools*

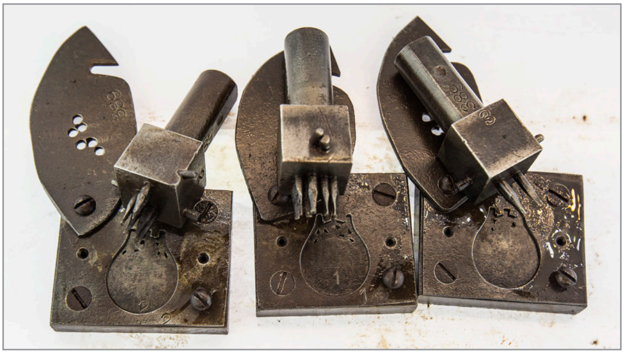

Figure 9 *Piercing tools*

Figure 10 *Closeup of middle piercing tool in Figure 9*

Close examination of the piercing tools in either tool set demonstrates a complicated process of pinning the piercing tools in place with tapered dowels (Figure 9). This allows for intermittent changing of individual piercing needles as needed.

My First Attempts in Making Filigree Rings

In 1991, I was working as a bench jeweler in a trade shop and experiencing numerous requests from customers for serviceable filigree rings. I started accumulating filigree rings by buying estate pieces for scrap over the counter and from antique dealers, scavenging for any filigree pieces I could use for parts.

Early attempts meant I would repair, refurbish and attach a sprue rod and make vulcanized rubber molds that I used to “try” to create pieces for lost-wax casting. In hindsight, notable was my lack of knowledge about how American die-struck filigree rings were originally made and where they had come from. These early attempts were done without any hubs, dies or drop hammers. The models were constructed without making any new parts but only from cannibalizing old parts. As most of these old parts started as thin sheet metal and were often worn, polished and repaired to a thinner gauge, it was pushing the limits of what the materials I was working with were capable of. Put quite simply, I couldn’t inject and pull a wax from the great majority of molds I attempted.

Besides the problem of the thinness of the materials I was working with, there was the problem of the four copies I had to make, starting from a cobbled-together model and ending with a shippable piece. Each iteration resulted in a marginal loss of detail due to copy errors of shrinkage and finishing.

How to make a filigree ring from salvaged parts:

1. Assemble a filigree ring from salvaged, repaired parts.
2. Create a rubber mold (1st copy).
3. Inject and pull a wax ring (2nd copy).
4. Invest for lost-wax casting (3rd copy).
5. Cast, finish and polish piece (4th copy).

Figure 11 *Model # R071 filigree ring for 6 mm round, modeled from salvaged parts*

Despite a dismal failure rate as far as usable molds were concerned, I had put together a small assortment of filigree rings that I could reliably reproduce by vacuum-assisted lost-wax casting. There were nine pieces in my first printed one-page catalog. Despite the limited offerings and marginal quality of the pieces, the early returns from the marketplace created an interest in developing more models to include in a larger catalog. This is when I serendipitously discovered Providence, Rhode Island.

Providence, Home of the American Industrial Age

Providence is the home of both the Industrial Age and the jewelry industry in America. Providence was a commercial shipping port where ship captains trading in the triangular route of African slaves, Caribbean molasses and Colonial rum congregated (Figure 12). As entrepreneurs, they generated work for silversmiths and goldsmiths to turn precious metal bullions into value-added goods such as buttons, buckles, holloware and flatware. From this concentration of craftsmen in the late 1790s, Seril Dodge began experimenting successfully with methods of making clad metals. At the same time the textile industry in this country began with the opening of the Slater mill and the machine-making industry began with the Wilkenson machine shop in Pawtucket in 1797.

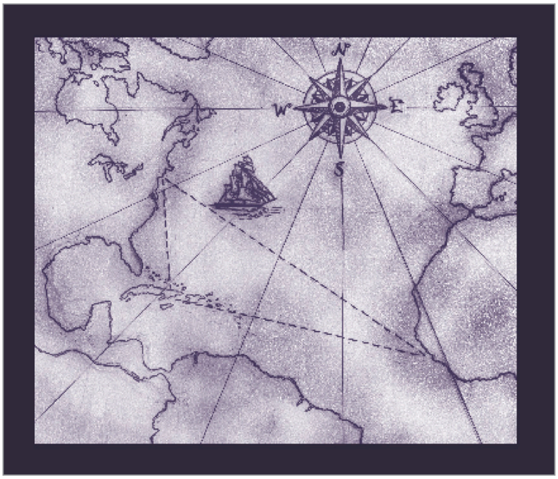

Figure 12 *Triangular shipping trade route of Providence ship captains trading in African slaves, Carribean molasses and colonial rum*

"The development of the metal working industry in Providence was instrumental in the ongoing growth of the jewelry industry, for it attracted and served as a training ground for a pool of skilled machine tool makers that would construct the early jewelry manufacturing machinery that would be increasingly critical as the industry mechanized."[1] Together, the technological development of clad metals, the machine tools industry and Providence's location as an international seaport cemented Providence as the origin of the jewelry manufacturing industry in America.

In the mid-1940s, with the development of commercially available casting investment, the die-striking jewelry industry as well as its hub cutters and tool-and-die makers were making way for the less expensive lost-wax casting method of production. By the 1980s the jewelry industry in Providence was further savaged by offshoring to less expensive labor countries. By the time I discovered Providence in 1993, much of the early, first and second Industrial Age jewelry manufacturing infrastructure of Providence was being sold for scrap steel. My first visit to the Providence Jewelry District shown on the tourism map in Figure 1 revealed ruins being bulldozed to make way for highway expansion. (Figure 13).

Figure 13 *The providence jewelry district as I first discovered it in 1993*

On my first visit to Providence, I came home with several hundred jewelry hubs (Figure 2). Even though I had already been working in the jewelry industry for several years, I had no knowledge of Providence's place in history nor any understanding of the manufacturing processes that were driving the technology behind the small assortment of hubs I had stumbled across. What I did know for certain was that I was looking at beautiful artwork executed by very skilled craftsmen.

I think that it's important to note the general lack of knowledge surrounding the origins of the jewelry industry in America, even among those in the industry. After showing these artifacts to everyone I already knew in the jewelry business and finding no explanation as to how they were made or used in jewelry manufacture, I started sending copies of images of hubs with a letter of inquiry to places I expected might be helpful. I searched libraries, bookstores, universities with metal and jewelry programs, and wrote letters to historical societies and auction houses seeking references on the topic. I've found no substantial knowledge available on the subject of hub-cutting, die-sinking, and first Industrial Age jewelry manufacturing. Even today, searching the internet offers little useful knowledge regarding the topic. The topic of hub-cutting and tool-making, especially that concerning the die-striking and assembly of filigree rings is largely an undocumented art form.

The other thing I noticed at the time was that there was a tremendous opportunity to gather up these designs at a very low cost, in many cases for just marginally greater than what was being paid for scrap steel. With this in mind, I started two projects simultaneously:

1. Figuring out how to reproduce beautiful pieces of filigree jewelry from a hub
2. Finding and buying every hub I could get my hands on before they were all destroyed

How to Make a Filigree Ring

Filigree rings start from two basic configurations: the "T" shank and the "O" shank, appropriately named for their general shape (Figures 14 and 15). A finished ring contains two of each of these mirror-image pieces and may also contain several other pieces as decorative trims and stone plates. It's worth noting that T-shanks offer more design variations as their general configuration allows for more varied manipulation than an O-shank, whose general configuration allows for only smaller gemstones and fewer variations. With this in mind, I started trying to make filigree parts from hubs.

Figure 14 *Master hub for T-shank* ***Figure 15*** *Master hub for O-shank*

Limited by a workshop with a small floor plan, limited funds and a general lack of knowledge, I started by trying to duplicate what I had come to understand from the artifacts I had accumulated and explanations from people I purchased them from. Here are three basic facts surrounding these hubs.

1. A hub cutter cuts a “hub” from a piece of annealed tool steel. This process generally involves either deep-relief hand engraving or machining a piece in a three-dimensional pantograph such as an Augenstein or Janvier copy and reducing machine (Figure 16) from a plaster model called a “galvano” or a combination of both. This piece is then heat-treated to a hardened state.
2. The hub is forced into another piece of annealed tool steel to make a working die with a negative impression.
3. A precious metal blank is loaded onto the die and forced by a hammer or press into the negative spaces in the die.

Figure 16 *Image of an Augenstein copy and reducing machine*

These steps are an example of the simplest possible tool set for die-striking. Note that the hub is only used to create a working die. After the working die is completed, the hub is put in the hub vault for safekeeping until a new die needs to be made. A completed hub was the store of the design information and intellectual property and not to be risked in the rigors of manufacturing. It's noteworthy that the custom of the time was that the hub cutter never signed his pieces as these were the property of the company. The tool-making may continue to include forcing, blanking, trimming, piercing and forming tools.

This process, as was done in the first and second Industrial Age jewelry industry, was completely dependent on tool steel and considerable pressing power. Today I have more jewelry replicating tools and materials to work with than my Providence predecessors did that allow the process to continue conceptually but to be less dependent on tool steel and tonnage. The important part of the process is the concept itself: Irresistible force meets movable objects and makes an impression. By substituting different materials to compensate for my lack of knowledge, lack of complete tool sets and lack of ability to deliver force, I have been able to duplicate the concept with mixed results. The main objective became to get to a precious metal "T" shank or "O" shank without complete tool sets or a drop hammer or screw presses.

Figure 17 *The HUGO KOHL hub vault containing over 7000 unique hubs, dies and rolls*

What ended up working was substituting two-part liquid, room-temperature vulcanizing rubber in place of the working die. By creating a dam around a hub and pouring a liquid two-part 0% shrinkage RTV rubber over the hub, I ended up with a faithful representation of what the steel working die would have been.

Figure 18 *Two-part RTV rubber mold "dummy die" of T-shanks*

As “T” shanks and “O” shanks were almost always stamped flat, this meant I could hand melt wax into the rubber die and pull a perfect piece that would then need to be cast.

There comes a significant advantage with this modification at this point in the process: We could start making thicker parts that would be better suited to casting as opposed to very thin die-struck parts. By selecting a wax that was both machinable and easily melted by hand, we had absolute control in critical areas where we needed thicker or thinner places designed into our parts. There were two more significant problems that arose from this process: copy errors and porosity in small cast pieces.

Here is the process for creating filigree ring parts without a drop hammer or press by replacing a steel working die with a rubber dummy die and forming in wax:

1. Select a hub (original).
2. Create an RTV mold/dummy die of the hub (1st copy).
3. Hand-melt machinable wax into an RTV die (2nd copy).
4. Invest wax shanks for lost-wax casting (3rd copy).
5. Cast metal shanks (4th copy).

These metal parts in step 5 that are four copies away from the original could now be trimmed, pierced and formed into a master model of a filigree ring that could be molded again to produce lost-wax castings. By the end of the process we had made nine copies from copies.

6. Build model ring designed specifically for lost-wax casting.
7. Create rubber mold of the new model (5th copy).
8. Inject wax (6th copy).
9. Invest wax ring for casting (7th copy).
10. Cast ring (8th copy).

Steps 5, 6 and 10 allow for minor touch-ups with a graver and/or milgrain wheel in order to improve detail resolution. That process has been greatly helped along by developments in air-assisted engraving and graver sharpening fixtures. Challenges also include the general microscopic porosity inherent in small, lost-wax cast parts where metal was flowing through low-volume areas towards larger volume areas. The best we have been able to do is to experiment with different alloys and accurately follow suppliers melting and casting instructions.

Figure 19 *Model # R052 filigree ring for a 3 mm round stone made without presses from a rubber dummy die*

Die-Striking and Assembling Filigree Rings

As we continued to find additional "T" and "O" shank hubs, we also would occasionally find corresponding complete or almost complete die sets that included blanking tools, trim tools, piercing tools and forming tools. We were also finding and adding drop hammers, percussion presses and screw presses to the shop floor. As it became possible, we set up complete lines to go from embossing in the drop hammer to trimming and piercing in screw presses to forming, assembling and stone setting at the bench. Once the tools are properly set up in the drop hammer and screw presses, all of these operations, with the exception of piercing, are very straightforward. Carefully fixture the tools in a drop hammer or screw press and the rest takes care of itself.

The biggest challenge in this type of setup are the piercing tools (Figure 20). Setting the piercing tools in the screw press is a very slow and precise process where even the slightest mis-alignment results in breaking the male tines of the piercing tools. Proper alignment includes ensuring the screw press on the shop floor is level. These tools are fragile, intricate and made of many small parts that, when operated, are put under extreme pressure. They are also pinned together with numerous delicate, tapered dowel pins.

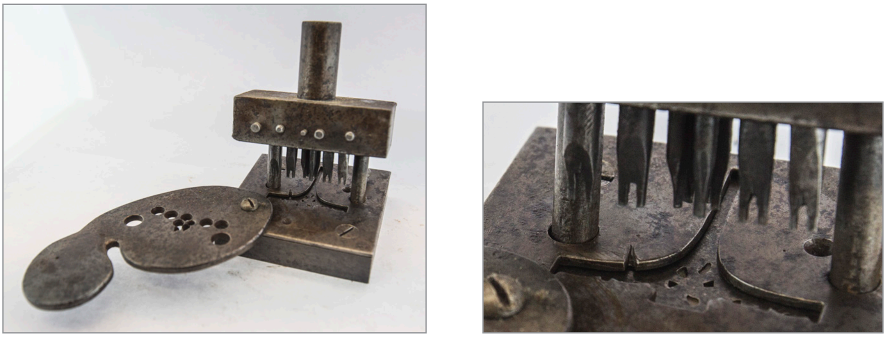

Figure 20 *Detail of piercing tool*

At this time, after 20-plus years of studying and thinking about how these tools were originally constructed, it is still unknown to me what the process was to create and assemble a set of filigree piercing tools. Our inability to properly repair these very rare tools has always been a hindrance to using them in a regular way. In order to preserve the integrity of these piercing tools for those who come after us—to be able to examine and learn them—we choose to, in most cases, leave them safely on the shelf.

Most die-struck filigree rings were produced for a very short time period: the 10 years between 1925–1935. While very popular in the marketplace, the cost of goods sold, mostly due to the high costs of maintaining these tools, made filigree jewelry a financial burden to its manufacturers. I seriously doubt that this genre of jewelry design was ever very profitable for any of its manufacturers. For the same reason, all of the filigree rings we offer to our wholesale customers are cast pieces. We create several purely die-struck filigree rings per year, solely on a commission basis. These are commissioned by "connoisseur"-type retail customers who desire a one-off, historically correct and unique piece of filigree jewelry. It's worth noting that when we do this, we do the piercing entirely by hand so as to avoid the risks and difficulties of dealing with the piercing tools.

Die-Striking Order of Operations

1. Blank in a screw press. In this operation we stamp out a blank from half-hard .020–.040-inch material.
2. Stamp/emboss in a drop hammer. This involves annealing and repeating as needed.
3. Trim in screw press. This operation trims the flash created from embossing.
4. Pierce at the jeweler's bench by hand with a jeweler's saw frame and broach. While this is slow work, it's more economical for us than doing it in a press with the old piercing tools.
5. Form either by hand or with forming stakes. This operation, depending on the metal involved, might include annealing with an air quench.

6. Assemble at the bench. This includes soldering and adding stone plates and/or trims. Care is taken to only air quench.
7. Set stones.
8. Polish and clean.

Modified process combining old and new Technologies

There is no way to overestimate the advantage contemporary jewelry designers and manufacturers have when it comes to availability of off-the-shelf solutions to product development challenges. With every new tool catalog comes a new season of opportunities to try to find better ways to be more efficient in our very competitive marketplace.

In this iteration we've found a happy medium between both of the above methods. It's useful when we only have a hub but no die. It is also a preferred way to create a master model that will be used to create a rubber mold because it allows us to fabricate a thicker model for a better casting and reduces the number of copies we have to make from copies and, therefore, mitigates the effect of copy errors.

1. Sink a die from a hub. This is done in a drop hammer or a percussion press. We use O1 tool steel or brass or copper for this operation. The brass or copper is good enough for a very short run of stampings. The steel can be tempered to appropriate hardness for longer term usage.
2. Create a false working die using RTV rubber.
3. Create a wax model of an "O" or "T" shank by hand melting into the RTV die.
4. Cast the pairs of shanks in sterling silver.
5. Trim the shank pairs.
6. Stamp the shanks in the steel or brass die to "bring up" the details. This method creates great-quality parts to use when creating a filigree ring model for production of lost-wax castings.
7. Pierce out the filigree at the bench by hand with drills, a jeweler's saw and broaches.
8. Assemble parts at the bench into a new model filigree ring. This may include adding setting plates and trims.
9. Attach a sprue rod and make a rubber mold (1st copy).
10. Inject a wax (2nd copy).
11. Invest (3rd copy).
12. Cast (4th copy).
13. Finish, set stones and polish.

Figure 21 M*odel # R101 filigree ring for a 6.5 mm round*

The Importance of Early Industrial Age Jewelry Design from Providence, Rhode Island

When we first step into the Industrial Age and the artisanal craftsman collides with tool steel and industrial power, we see the craftsman at the height of his abilities. The quality of craftsmanship, the ability to do fine-resolution work by hand and to exert control in one's medium were extraordinary. When it came to hub cutting, these artists pushed at the very limits of what humans are capable of doing in artisanal handicraft. Since then, we have seen increasingly efficient, well-intentioned industrial tool design remove not only drudgery but also the necessity of many skills from our day-to-day activities in the workshop.

In a dramatic example of how that expresses itself in modern-day jewelry design and manufacturing, we can see the jewelry design "technician" sit down to the keyboard at a CAD-CAM workstation and combine design elements from a menu-driven software package and "build" a piece of jewelry without any training in the arts or having handled any metal or touched any tools other than a keyboard and a mouse. One of the possible attributes of this kind of modern jewelry design is a disconnect from the very tactile jewelry-design experience inherent in the period pieces designed and built in first and second Industrial Age Providence.

Jewelry Making vs. Jewelry Manufacturing

Before the Industrial Age jewelry factory, jewelry was in the exclusive domain of the wealthy elite and unavailable to the lower classes of the population. A wealthy patron would commission a goldsmith to make a unique piece entirely by hand. With the onset of the Industrial Age, we stepped into the world of "art by means of mechanical reproduction." We left behind the world of the "original" and stepped into the world of identical copies. The importance of the ability to make copies cannot be overestimated. Besides the economies of scale, it created the ability to do capitalism. It allowed the masses to possess the same design content as the wealthy elite. Pieces were made in karat gold for the wealthy, clad metals and sterling for the newly emerging middle class, and brass at a low price point. This is a very important cultural distinction that expresses itself throughout the newly industrialized world but is unique in how it expresses itself in American jewelry design.

The demand for jewelry among a new Industrial Age invention, the middle class, was insatiable. The Providence output was distributed and sold wherever merchant ships and, later, trains leaving Providence traveled to.

"In the 1790s there were several small artisanal goldsmiths' and silversmiths' shops taking commissions from wealthy sea captains and merchants in the Providence area. By 1810 there were over 100 craftsmen in the Providence jewelry trade. By 1820 there were 300. In 1875 there were 2,667 jewelry workers. By 1880 Providence had over 3,000 jewelry workers and by 1900 over 7,000. By 1905 there were over 8,400 jewelry workers in Providence."[2]

Besides the economic importance of this commerce, there was the cultural significance it represented and how it was expressed in the ornaments it produced. When we first gained the ability to do "art by means of mechanical reproduction," factories had to make very consequential decisions about which art was worth the effort of reproduction. This was no simple matter to early factory owners. The cost of early steel was dear and the cost of tooling up to manufacture die-struck jewelry was exorbitant and not to be taken for granted. Artists, i.e., hub cutters, turned to the traditional images that had been within the cultures from wherever they had come.

Another attribute of these artists is that they were classically trained to be masters of understanding the math and science of what humans saw to be beautiful and expressing it in miniature sculptures. They understood symmetry, proportion, perspective and composition. While these images of ornament were coming from numerous cultures (Providence was a melting-pot city of immigrants), once they came to America and collided with the Industrial Age they became "Americanized." What was uniquely American about how these images transmuted into jewelry design is that they were configured to express uniquely American ideas about personal liberty and romantic love.

Neither of these revolutionary, radical ideas were part of any practical application in an average person's day-to-day life until the Industrial Age came to America. Away from the paternalistic controls of the monarchy of Western Europe and just as well away from the familial control of cottage industry and the family farm, people started making their own choices about who they would marry, where they would live and their vocation, based on personal interests and entrepreneurial optimism. Hub cutting and jewelry design in the first- and second-wave Industrial Age jewelry of Providence, Rhode Island, is an ethnographic phenomenon of a certain kind of expression of these ideas. It is also an undocumented form of American sculpture. I think that this is a much overlooked and underappreciated attribute of our jewelry-design culture.

There are only a couple of things that separate human beings from other creatures we share the world with. Other creatures feel emotion, have language, use tools, build complex structures, wage war and live in social groups. What is uniquely human is crafting a symbol and either affixing it to our own body or giving it to someone else we love and care about.

These symbols speak to the culture and customs we come from, our place in the world today and our aspirational hopes for the future. As Providence tooled up and grew into a juggernaut of jewelry design and manufacturing, it exported low-cost, affordable jewelry everywhere America traded. Through these images and ornaments, Providence infected the rest of the world with uniquely American ideas and memes about American-style liberty and romantic love.

While much (if not most) of this imagery has been lost to the scrapyard due to technology changes and numerous booms and busts of the Providence jewelry industry, there is still much to study and appreciate. I suspect there is still much to be discovered.

One Possible Future of American Filigree Ring Design and Manufacture

One attribute of the development of the Industrial Age and capitalism is the continual movement to replace humans with machines whenever possible. There are a number of reasons that this might be desirable. Machines can be used to deliver greater power, are more suited to operations that are environmentally risky to humans, more capable of accuracy in boring, repetitive operations, and are generally more energy efficient and less expensive to deploy. The future of manufacturing jewelry in general, and filigree rings in particular, is well suited to increased automation. Developments already being deployed by manufacturers allow for instantaneous customization of CAD-based files, and castable models are being printed for automated manufacturing lines.

One of the ways that the prodigious volume of high-quality design content from first- and second-wave Industrial Age jewelry manufacturing can be leveraged is to replace the old technology of die-striking and employ three-dimensional scanning of hubs, dies and rolls. These digital files would serve to build design libraries for CAD-CAM.

One of the reasons this is so desirable is that the design work is already executed in a three-dimensional form, the master hub. Another desirable feature is the quality of design content already organized by collections and jewelry types. Many of the jewelry hubs in the Hugo Kohl hub vault demonstrate a masterful understanding of the qualities that make design beautiful to humans. Hub cutters were trained masters of perspective, proportion and symmetry.

Another is the sheer volume of design. While at first glance one sees an individual hub as an individual design, upon looking closer one hub often contains a multitude of design elements. This begs the use of CAD and 3D scanning, which has the ability to extract and manipulate design elements in endless combinations.

The most important reason, in my opinion, to use technology to incorporate these vintage designs into the contemporary marketplace is their immediate relatability to the public. The artists who created these hubs were well trained in the attributes that humans see as beautiful. The designs are classics that have been with us for thousands of years and will still be classics thousands of years from now. They speak to the human condition and what it means to strive for a full and meaningful life.

Scenes from the Shop Floor

One of the attributes of a workspace is its conduciveness to creativity. Being able to venture in numerous other directions of product design has informed my thinking and contributed to my work in developing my filigree collections. Here are some of the interesting workstations that I use to make my filigree pieces as well as stimulate my curiosity and creativity in the workshop.

While at the Gorham Manufacturing Co, Heller designed and created the collection of decorative rolls seen in Figure 22. These rolls consist of a paired male (aluminum-bronze) and female (steel) tool set. The steel roll is the original carving. Made from a solid tool-steel rod, Heller would engrave and chase a design, cut in negative/intaglio relief around the perimeter of the roll. The male (aluminum-bronze) roll acts as a "forcer" to the steel-roll die. Having exactly twice the circumference of the steel roll, the aluminum-bronze roll is cored with a Morris taper and rides the main driven shaft of the mill.

Figure 22 *Gorham workshop with rolling mill and Heller rolls*

The relief on the aluminum-bronze forcer was created by coating it with Asphaltum Varnish and repeatedly passing it first over the steel roll and then soaking it in concentrated acid solution. In this way the forcer is machined to synchronize to the steel master.

Thin (.014–.016) dead-soft sterling in the form of sheet or holloware could be run between the rolls and lay down a pattern that would need little to no follow-up chasing. These tools greatly streamlined the manufacturing process and allowed for repeatable results in very complex and demanding designs. Heller's work creating these rolls and the purpose-built mill represent the very highest example of artisanal craftsmanship and in many ways define the capabilities and limitations of human control and resolution in craft.

Not only the workhorse of the first Industrial Age, screw presses were also the workhorse of the jewelry industry. Delivering between 12–50 tons of squeeze, these human-powered machines were not only efficient, they allowed the operator a great deal of control. Screw presses were also important because a factory could employ unskilled immigrant labor with little training. Simply being able to swing the flywheel was the only skill set a worker needed. It was common to have one skilled tool setter watch over numerous presses operated by unskilled workers.

Figure 23 *Screw presses set up to create work cells and shelves of old die sets*

Delivering between 100 and 175 tons, drop hammers (Figure 24) were very powerful machines. Manufactured by the Mossberg Foundry in Providence, RI from the mid-1800s to early 1900s, they were used in many processes including the forging of precious metals (gold, silver, platinum) with hardened tools. Drop hammers generated a crisp "smacking" force, different from the "squeezing" generated in a screw or percussion press. By heating the steel in the forge, we are able to sink dies with greater plasticity than we could into cold steel with drop hammers.

Figure 24 *Drop hammer pit with three drops, four screw presses and small forge*

Acknowledgements

My adventures in learning about and reproducing the die-struck treasures of Providence, Rhode Island, have not occurred in a vacuum. I give special thanks to Peter Dicristofaro, who has patiently guided me along the path and nurtured my education in the Providence-based culture of jewelry design and manufacturing. By allowing me to wander through the archives and among the artifacts of #4 Edward Street (where all paths of jewelry manufacturing intersect) and giving context to the collections of the Providence Jewelry Museum, he has added a special richness to my understanding of the art and craft of jewelry design and manufacturing.

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References

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