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The construction of large holloware forms

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ROCHESTER INSTITUTE OF TECHNOLOGY

THE CONSTRUCTION OF LARGE HOLLOWARE FORMS

A THESIS SUBMITTED TO
THE FACULTY OF THE COLLEGE OF FINE AND APPLIED ARTS
IN THE CANDIDACY FOR THE DEGREE OF
MASTER OF FINE ARTS

BY

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PREFACE

My goal is to supplement the reaches of the novice metal worker in the area of forming large holloware pieces. The texts available, which offer instruction in raising and constructing holloware, stop after the first basic practices are explained. This work is directed towards those who have begun to accomplish these skills but may still be in need of some additional information.
INTRODUCTION

Man has been forming metal for centuries with methods that have changed very little. Except for the introduction of machinery, often very large or expensive and beyond the realm of an individual craftsman, the techniques used today are the same as those used generations ago. The methods used to form large pieces are basically the same as those used in making smaller ones. Large pieces, however, present additional unique problems which are usually not encountered in smaller pieces. It is not my intention to deal with history but to offer a pragmatic guide to stimulate and assist the beginning metal worker in overcoming these problems.
CHAPTER I

GENERAL INFORMATION

Designing

As with making anything, the first problem is in the design. Although large pieces can be impressive because of scale this does not mean one necessarily has a good design. Large holloware presents a problem to the designer because the details and subtleties of an average scale piece, when enlarged, are no longer either detailed or subtle. To eliminate much of this problem the design must be drawn to full scale. Sketches must be enlarged. An overhead projector is excellent for this purpose. Sketching large on newsprint can also be helpful.

A large drawing compass is an invaluable tool for drawing designs and patterns and as an aid while working on the piece. A very good compass can be constructed from two pieces of eighteen inch wood three-eighths inch square. A hole is drilled through the two pieces and they are fastened together with a bolt and wing nut. Be sure to use three washers--one washer under the bolt head, one under the wing nut, and one between the two sticks. A small nail is pushed into one stick as a compass point and a hole is drilled up into the other stick to hold a pencil or marking pen.
Pattern Making

Once the design is decided on the pattern must be made to determine the amount of material required. At this point the size of the material needed may become the determining factor as to whether a piece can be made or not. If the appropriate size material needed is not available, it may become necessary to change the design or the scale of the piece or alter the pattern to accommodate the material available.

If a piece is to be made only once, the pattern may be constructed of any suitable paper. If the piece is to be repeated or if it contains multiples of the same shape, then use a more lasting material such as poster-board. The pattern should be cut from sheet metal for a piece that will go into large production.
Materials

The traditional metals available to the hand craftsman are silver, brass, copper, bronze, pewter, steel, and aluminum. The factors involved in choosing which metal to use are color, cost, strength, solderability, and patinability. However, the most critical factor in deciding on a material is availability.
Preparing the Metal

Cutting

When the final pattern is determined and layed out the metal is ready to be cut. A bench shear is most convenient. A pair of airplane snips, with one handle held in a vice and a length of pipe over the other handle acting as an extension, is an extremely helpful substitute when a bench shear is not available. Leather work gloves are also very practical. They furnish protection from burrs which can cause severe cuts and also provide a firmer grip. After the piece is cut, file the edges very carefully to remove any remaining burrs or sharp spots. Any scratches should be removed from the surface of the metal at this time.

Annealing

The metal must be annealed completely. To assure proper annealing an annealing hearth may need to be constructed. Depending on the shape of the metal to be annealed, one may construct either a permanent or a movable hearth. Fire brick is very convenient. The bricks may be laid to conform to any shape of metal being annealed. It could also be constructed from a large sheet of three-eighths inch thick transite placed over a pumice tray to allow rotation of the piece. However, this is not very sturdy and the bricks offer a better annealing surface. When annealing a flat sheet of metal it is best to place a few pumice stones under the sheet to allow the flame to pass under the sheet as well as over it. This assures a more uniform annealing. After the piece has been annealed it should be pickled to remove the oxides left after heating. This may not be possible yet
because the piece may be too large to fit into the pickle container; therefore, one may begin forming the piece before pickling.
Forming

At this point the metal is most difficult and awkward to handle. Here, again, the leather work gloves provide a firmer grip. Holding the metal against a stake to begin the first raising on a large piece can be simplified greatly by placing the metal on a dapping stump and dapping the first row of hammer blows using the raising hammer. This will allow an angle to form from which the rest of the raising will proceed.

It is more convenient to sit down while raising. This position is less tiring than standing and allows you to rest the metal on your lap or knee. This helps maintain the metal at the proper angle for raising. It is best to sit on an adjustable height stool in order to more easily control the angle of the metal being held for raising.

The metal may begin to assume an inverted shape during the first raising. Should this occur, the best way to reshape the piece is by placing it on the floor and stepping on it forcibly from the inside. This will reshape it properly for raising.

Fluting is essential when raising large forms. After the raising has begun a great deal of time can be saved by using the fluting technique. The desired angles for working the piece are most easily attained by adding more flutes as soon as possible. The additional flutes should be added as in diagram 1.
Diagram I

Adding Flutes

a. first fluting
b. second fluting
c. third fluting
More vibrations are set off by hammering a large piece than a small one causing the metal to harden more rapidly. Therefore, a large piece will have to be annealed several times during each raising course. The annealing should be done with the piece inverted to allow the edge to be heated more evenly. When annealing a form, other than a bowl shape, back the piece with fire brick or other suitable materials which will reflect the heat back onto the piece. Annealing with two torches at one time can speed up the entire operation.

A twenty ounce raising hammer is a good weight because it is heavy enough to move the metal easily without a great deal of strain on the worker. A wooden raising hammer, which leaves scarcely any marks on the metal, may be used on soft metals.

It is very easy to become lost in the working of a large piece resulting in an uneven raising and an undesirable shape. To avoid this, always complete the course being raised. This may be difficult, especially on a large piece, but the additional work saved in trying to correct mistakes makes it well worth the effort. If for some reason you are interrupted, make a notation of the place and direction of working on the piece with a water soluble marking pen. When work is continued the marks may be wiped off with a wet paper towel. I suggest these markers because they leave a line easier to see than a pencil line. Most important is that they come off easily. Pencil lines are hard to remove. Neither the fire of annealing nor the pickling acid will remove them.
CHAPTER II

PROJECT PIECES

Piece 1

I began my first piece from a twenty-four inch disc of twenty gage brass. The raising was started on a wood raising stake using a twenty ounce hammer. The piece became work-hardened very quickly. Not realizing that this was the reason that the piece was becoming so difficult to work, I switched to a heavier hammer. A heavier hammer does move the metal more easily; however, you become tired much more rapidly and the increased weight of each blow destroys the wood stake very quickly. After annealing the first time, I determined that work-hardening was the problem and not the mere size of the piece. I stopped using the heavier hammer when I realized this fact.

Another problem that arose in the beginning was the movement across the floor of the tree stump that was holding my vice and raising stake. This movement was caused by the heavy force of the hammer blows and resulted in a change of the raising angle. I found the best way to secure the stump was to nail boards into the floor around it. I also found it helpful, at times, to stand behind the piece and raise by striking backward towards myself rather than in the traditional manner of away from myself. There were several reasons this was helpful. It offered a change of position when I became tired and broke the monotony of the process. The greatest advantage was that changing
the side I would be working from would stop my knuckles, on the hand holding the hammer, from striking the piece. When raising from behind the piece it made the work easier if I stood on something to raise myself four to six inches; lowering the stake on which I was working. In moving from the front to the other side it is easier to stand on something rather than lower the stake.

I began raising at too steep an angle and soon damaged the rim of the piece. Two inches of the outside edge had to be cut off. When working on a large piece the danger of raising at too sharp an angle becomes quite acute. The progress comes so slowly that you become impatient and try to push the piece.

The piece no longer fit the wood stake as the shape progressed and I switched to an iron raising stake. When the raising was finished I measured my piece and discovered that the heavy blows on the iron stake had stretched the metal enough to recover the two inches removed from the edge. The two inches would have meant a significant change in the piece since they would have been four inches on the final dimension. I had made a lucky discovery which I could use to increase the size of a piece that had no waste.

The piece was then shaped and planished on iron stakes in the usual method. I found a heavier planishing hammer to be handy, because the base was to be planished smooth and this was the area of the deepest raising marks.
Piece 2

The second piece was raised from an eighteen inch disc of twenty gage brass. The piece was raised entirely on wood. The indentations were dapped and then raised in on wood stakes I made to fit the left and right sides of the feet. The feet were also dapped and stretched down on a sand bag. The piece was raised using a twenty ounce raising hammer and a variety of dapping hammers. The final shaping was done only with a wood mallet which would not destroy the texture left by the raising hammer. For the same reason only a five ounce planishing hammer was used where the piece needed to be planished.
Piece 3

The third piece was made from a twenty-four inch disc of twenty-gage brass and three one foot lengths of quarter-inch round bronze rod.

The raising was begun on wood and then proceeded to iron stakes. Because of the height and shape of this piece it was necessary to locate an extra long raising stake, and much of the raising had to be done from behind the piece.

Planishing became a problem because the bottom was to be smooth and a stake could not be gotten in that far. To overcome this problem I found that an assortment of heavy pipe both round and square in diameters from one to three inches made ideal extensions to hold planishing stakes.

While working on this piece the noise of the hammering became quite obvious and I started to use ear plugs while hammering.

When the bowl was finished I forged the brackets for the hangers and silver soldered them in place around the piece. The hangers were then made by wrapping cotton cording.
Piece 4
Piece 4

The bowl for this piece was raised from a twenty-four inch disc of twenty gage brass. Although it is larger than the other ones it required less work to raise because of the shape. Constantly drawing guide lines on the piece while working helped a great deal to bring it up evenly and quickly. There was no problem getting stakes inside the piece. The planishing was done with both the heavy and light hammers. The final shaping was again done with a wood mallet to preserve the texture.

The base is forged iron. The center rings are forge-welded together and the three legs are arch welded to them. The bowl rests on the base without attachment.
Piece 5

The three brass forms in this piece are made from a pattern similar in shape to one that would be used to form a spout for a tea pot. The twenty gage metal was twenty-four inches long and fourteen inches at the widest point.

These shapes required an overlapping seam of about fourteen inches for which I used hard solder. Extra long tweezers were required to place the solder along the seam and gloves had to be worn to protect my hands from the heat. An extra long soldering pick was also required while soldering.

As the seams were completed I began to raise in the narrow parts of the forms and dap out the bellies. The narrow parts were raised in using my standard twenty ounce raising hammer working both on iron stakes and on air over a dapping stump. The bellies were formed with a variety of dapping hammers. The forms were planished and the parts that were to be soldered had to be completed to final polishing because they would be inaccessible after soldering.

The pieces were stamped on the inside with a small number to afford reassembly in the same order as they were being formed. This would guarantee a proper fit when soldering.

I held the parts together with small C-clamps while doing the final annealing, shaping, and planishing before soldering. The metal at the seams was polished and the joints scraped in preparation for soldering. The parts were held in place with the small clamps on the inside. The use of clamps eliminated the need for interlocking tabs or binding wire. I placed the solder on the outside allowing it to flow down into the seam as the heat was applied to the inside of the
forms. Safety glasses and gloves had to be worn to protect myself from the heat being blown back out of the piece. Hard solder was used because the forged iron parts were to be soldered over these seams. The excess metal where the clamps had been holding was cut out of the inside and the edges filed smooth.

The iron parts of the piece were now formed. Easy flow silver solder was used to attach the iron to the brass.

A commercial chain was used to hang the piece from the wall mounting. I burned the galvanizing off the chain in the forge and reshaped the end links on the anvil. The chain was then reheated and given an oil finish.
A large piece requires a number of extra annealings. A heavy build up of fire scale is left on the surface of the piece which leaves very beautiful colors. I chose to use these colors of heat oxidation and therefore had to be careful in finishing the pieces so as not to alter the colors. I have not discussed the finish on any of the pieces until now because they are all very similar and were done after all the pieces were completed.

The first piece is a graduation of bright metal color at the base to the dark color of oxidation in the body. This was accomplished by first tripoli and rouge polishing the base and then placing it upside down on the annealing hearth. Heating the piece slowly at the hearth allowed the color from the heating to bleed into the bright polished area. The same technique was used on the second piece. However, since the inside of this piece was as important as the outside it was not turned over to also allow observation of the colors on the inside.

The third piece was heat oxidized also. Extra care had to be taken in the areas where the attachments had been soldered around the piece. Although these pieces were not soldered directly to the bowl, flux from where they had been soldered had dripped and caused uneven coloration which had to be corrected. Always when heating the pieces to produce a desired color I had to be careful not to anneal any of
them and destroy their resistance to denting or other damage. The third piece was especially critical because extra oxidation was necessary under the brackets which would support the pieces and need the most strength.

The fourth piece was not oxidized. I bright polished it with tripoli and rouge.

The last piece needed extra care where the soldering was done. In the areas under the iron, both heat and chemical oxidation were used. After the three narrow parts were darkened, the highlights were brought out by rubbing them with a nylon scouring pad. This works better than steel wool or sandpaper because it does not clog-up or wear-out as fast.

The iron on all the pieces was heated and given an oil finish.
CHAPTER IV

CONCLUSIONS

While determining the amount of metal necessary to construct many of the forms I designed, I quickly realized that the availability of material was the most critical factor in determining if a piece could be made. Material was not available to do many of the designs I had drawn.

The most important thing I learned was that the ability to improvise and the quality of patience were two of the most essential factors involved. At times stakes had to be made or new ways found to hold them. Solving these problems proved very gratifying. Patience, above all, proved most important. The amount and duration of physical labor involved in doing a large piece is tremendous. The motivation to patiently wade past all the labor must be ever present or the proper completion of a large piece of holloware will never take place. However, I believe I have presented sufficient helpful information to allow someone starting a large piece, for the first time, to successfully achieve his goal.
APPENDIX

LIST OF TOOLS

Cross-peen or forging hammer
Extra long solder pick
Large stakes
Ear plugs
Extra long tweezers
Custom annealing hearth
Leather work gloves
Extra large pickle bath
Safety glasses
Water soluble felt marker
Extra tall height gage
1"-3" diameter pipe
Planishing hammers
Extra large compass
Strong pickle tongs
Raising hammers
Dapping hammers
Wooden mallet