FROM SMALL TO LARGE:
A CONTEMPORARY ENLARGING TECHNIQUE FOR SCULPTURE

Monika Braham

A Thesis

in

The Faculty

of

Fine Arts

Presented in Partial Fulfillment of the Requirements
for the degree of Master of Fine Arts at
Concordia University
Montreal, Quebec, Canada

April, 1978

ABSTRACT

FROM SMALL TO LARGE: A CONTEMPORARY ENLARGING TECHNIQUE FOR SCULPTURE

Monika Braham

This thesis describes an enlarging technique designed for contemporary materials (fiberglass reinforced plastics and foam), and which requires relatively common-place equipment.

In the introduction, the principles of the traditional, most commonly employed enlarging techniques are briefly discussed. This will afford an understanding of the benefits and limitations of the various methods, and of the way in which they differ from this more recently developed system.

The subject technique was developed by John Ivor Smith, with the intention of finding a more satisfactory and economical method by which to enlarge his two Expo-Commissions.

The scope of the text covers the description of the technique in nine steps. The steps demonstrate the working process in detail, including problems likely to emerge.

The text is complemented by photographs to clarify the process as it develops from the original maquette to the final, enlarged piece.

ACKNOWLEDGEMENTS

I should like to express my indebtedness to Professor John Ivor Smith, who first introduced me to, and later instructed me in this particular enlarging technique, and who helped me to solve the type of problem unique to each sculpture.

John Ivor Smith also provided coloured slides from which black and white photographs were made to illustrate various techniques and methods. These were taken while he was working on his own enlargements, and assisting other sculptors, who had adopted this technique to enlarge their own work.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

Page

Page

CHAPTER I

INTRODUCTION

This paper will describe, step-by-step, the working procedure of a recently developed technique for the direct enlargement of sculpture involving volume. It is specifically designed for such contemporary materials as fiberglass, resin, and foam and very common-place equipment. The method has the advantage that it can be carried out by one person unaided, provided, of course, the scale increase is not too colossal.

By direct, it is meant that there is no subsequent casting of the enlarged piece. The process involves the direct construction of the final enlarged sculpture, in contrast to the long and more commonly employed method of "pointing" and enlarging "by eye and direct measurements". Those methods utilize the conventional approach of first producing a proportionally enlarged copy of the maquette in either clay or plaster (modelled over an armature) from which a mold is made. The final piece is then cast, usually in bronze.

A further benefit of this method is that it will produce a more precise enlargement of the original maquette, than is achieved by any of the more traditional techniques.

"For better or for worse, what you see is what you get . . . only larger."[1] Therefore it is advisable to evaluate the maquette carefully before making the enlarging. It is necessary to determine whether or not the sculpture, though small and intimate in scale, has a monumental quality justifying enlargement.

While sculpting the maquette, it is useful to view it from a low angle with one eye closed to approximate the full scale viewing situation. In doing so, one can rapidly develop the ability to work in one scale for maximum effect at another scale. It should be kept in mind, because enlarging is a very time- and energy-consuming procedure, that it is not worth the effort to merely "blow up" a piece for the sake of seeing it in a larger size.

When used directly, the method does not permit major alterations on the final full-sized sculpture. However, when used indirectly, the technique lends itself to changes at the increased scale, but for the sake of clarity, this will not be touched on until later. Therefore, if all problems and changes are completely solved on the maquette, we can expect to minimize labour and to utilize time and materials in the most economical way. Painstaking correction of errors on the maquette has proven itself to be enormously time- and energy-saving, and perhaps more importantly, it reduces frustrations. Jacques Lipchitz had his work enlarged "by eye and direct measurements" and he writes about his experience in his book My Life in Sculpture.

> . . . "The Bellerphon Taming Pegasus" is a very large sculpture (38'), but it is light in its proportions, because the building is also light.

The building he refers to is the School of Law for which the sculpture was commissioned by the University of Columbia. He then continues to explain his enlarging procedure:

> . . . I started from the maquettes, then made sketches three times larger and then

models three times larger than those. From this the final version will again be enlarged by three times. I worked like this because, when I am making accurate enlargements, elements change until I come to the final dimension. When you have enlarged a sketch twenty-seven times, a small inconspicuous detail can become monstrous and out of proportions, so you have to watch and to correct constantly what you are doing until you come to the final expression before you start casting the piece.

The first sketches for Bellerophon were made in 1964, later ones in New York in the winter of 1964 and 1965; then the one-third enlargement was made in Italy in 1966. I worked a long time on this. The final enlargement was started about the winter of 1967. The plaster was actually finished last year, in 1969, but when I first saw it, I was horrified because it was all wrong, and I had to have the enlarger start all over again.[2]

1. "Bellerophon Taming Pegasus", plaster for bronze, 38' high, by Jacques Lipchitz.

It is evident with the technique of enlarging "by eye and direct measurements" as well as with "pointing", the sculpture can be changed for better or for worse, but a precise reproduction of the maquette is unlikely to be achieved. Both of these techniques almost invariable involve a loss of much of the vitality of the original maquette due to lack of precision. An example of this is Henry Moore's "Warrior with Shield" in the Art Gallery of Ontario, of which the maquette is in my opinion, incomparably superior.

2. "Warrior with Shield" by Henry Moore, enlarged piece and maquette.

3. Process of enlarging by eye and direct measurements, "Warrior with Shield", by Henry Moore.

Another advantage of this new technique is that it has no scale limitations. A piece can be blown up to any conceivable size. A most striking example of this is H. W. Jones' "Love" at Place du Portage in Hall. It was enlarged by this method from a 12" high maquette to a sculpture 50' in height (illustration on following page).

4. "Love" by H. W. Jones.

To my knowledge, a precise and direct enlargement of such monumental scale is unprecedented. The unwieldy mechanisms used in "pointing" are limited to a size beyond which they are ineffective, and enlarging "by eye and direct measurements" has shown itself to be one of the most inexact and uneconomical methods in many respects.

The sculptor's concern for working in large dimensions guided by a system designed to maintain accurate proportions is as ancient as the dawn of western sculpture. One can trace three-dimensional enlargement back some 5,000 years to the Egyptians of the Old Kingdom who created the first sizable sculpture in their own image. Those first sculptures in the round were made on a human scale. Apparently the figures were carved directly, according to a canon of proportions which standardized the relations between the various body parts, their measurements, and the positioning of the total figure. Unfinished pieces have been found with a series of parallel lines directly drawn on them, suggesting a grid. From this evidence, all kinds of deductions have been made, including the proposition that the lines were drawn as part of a "pointing" system.

"Pointing" is a method designed to reproduce a form "identically". This is done by establishing systematically a series of points marking the projections and recesses of a form. The location of these points in space is then measured by various mechanical means in order that they may be transferred to either an enlarged, reduced, or same-scale model. If the reproduction is direct, (usually into stone or wood) surplus material is removed, until a series of points is reached. The points are realized by drilling into the block within millimetres of the desired surface. When a cast in bronze or other materials is intended, the enlarged piece is first modelled in either clay or plaster, the mass being built up over an armature, until the form reaches the points. From it a mold is taken and then the cast of the piece is made.

The speculation that the method of "pointing" was employed by the early Egyptians is refuted by the art historian Iversen, who states that, because the canon was strictly applied to all figures, there was no need for any other mechanical system.[3]

The fact is that there is not enough data available to substantiate any of the deductions, but some early Egyptian sculptures with a series of lines drawn on them do exist. Evidently, the Egyptian sculptor was subjected in his working method to a mechnical system devised to secure correct proportion in his work.

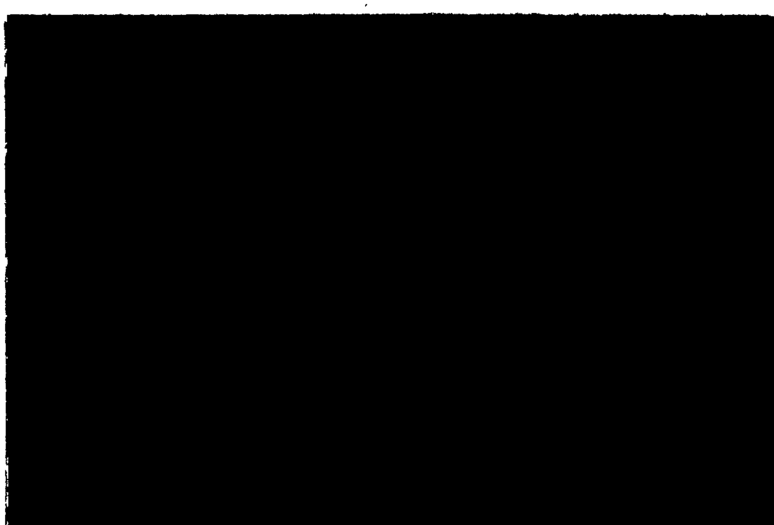
It is generally accepted that the Egyptians made use of the method of "squaring up" to enlarge some of their reliefs.[4] The model was divided into a grid of identical squares. The design contained in each model square was then transcribed to its corresponding square on a larger grid.

It is believed that occasionally, the same system was applied to the carving of free-standing figures. Because of the strict frontality of Egyptian sculpture, a linear system could have been utilized. The grid would have been drawn on the block and as the surplus material was chopped away, it would have been renewed on successive planes. It is, however, not known whether "squaring up" was employed for the purpose of enlarging a maquette, or merely to ease the process of carving. The proportions of the final pieces conform to the canon.

Although the use of "pointing" dates back to the Greeks of the first century B.C.,[5] it was not until the Renaissance in Italy that anything was documented about enlarging techniques.

During that time, sculptors were keenly interested in the proportional enlargement and reproduction of sculpture, and some were even commissioned by their patrons to enlarge and reproduce famous antique originals.[6] Consequently, various enlarging techniques were devised. Some of them are still employed, as for example, enlarging by framework or chassis.

The complete process of this method is indirect (except when applied to carving) and as any other variation of "pointing", involves the construction of an armature, a modelling of the final size piece, molding, and subsequent casting. The distance and depth of the points are measured and transferred by means of two wooden frames or chassis.



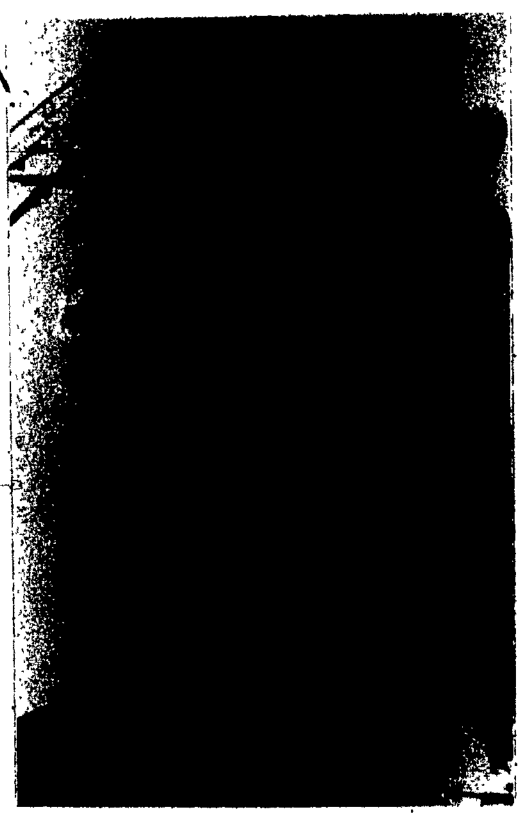
5. Chassis for enlarging, large frame with enlarged piece, small frame with maquette (18th Century).

One frame fits the maquette and the other is constructed with dimensions enlarged by the ratio of the proposed enlargement. The horizontal and vertical distances of any given point from the frame are measured with an adjustable T-square hanging from the horizontal frame-top. Its distance in from the frame, or depth, is found with a pointed measure stick that must be held perfectly level and at right angles to the T-square.

6. Frame of chassis.

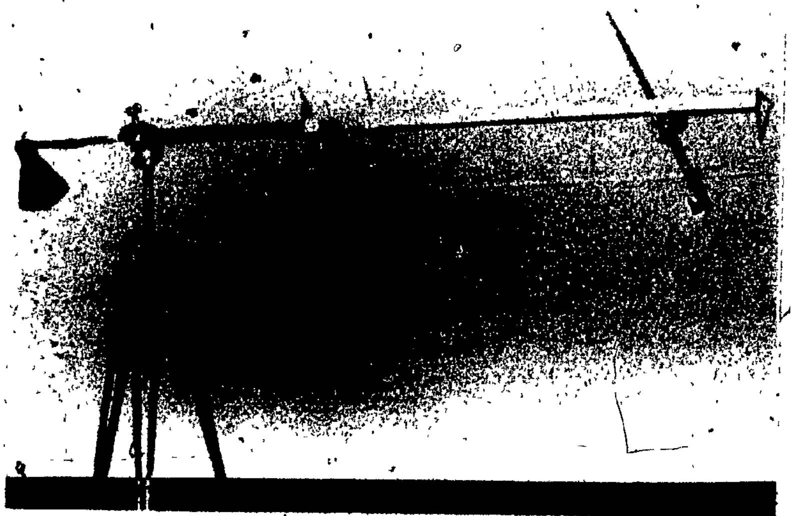
Equal linear divisions are marked off along the edges of the top frame, the length of the T-square, and pointing stick. If the enlargement is in stone, the block is placed into the center of the second frame; if in clay or plaster, an armature is erected. Measurements are taken from the maquette and transferred to the piece in the larger frame, which has linear divisions proportionally larger than those on the maquette frame.

Since the development of some sophisticated and much more efficient pointing machines, this wooden frame process has been largely replaced.[7]



7. Enlarging machine, Reul Type.

Before the pointing machine is put into operation, a system of points is established on the maquette. This may be done by simply choosing informative points or by drawing a grid on the maquette and using the intersection points.



8. Scopas Enlarger by John Tiranti.

The pointing machine is an elaborate movable pantographic instrument consisting of a long bar, or hollow tubing, to which two points are attached (see above illustration). The pointers are set into movable sockets, so that points in different positions can be taken. One pointer is proportionally longer than the other, but both move in sympathy with each other in any required direction. The short pointer is moved over the surface of the maquette from one point to the other, while the long pointer registers the distance and depth in the ratio of the desired enlargement.

The process of the subject enlarging technique is carried out without the aid of any mechanical construction or machinery that could cause restrictions in any respect. It differs from the traditional methods in that it utilizes, as in ship construction, full contours instead of isolated points. This accounts for the increased precision whereby the vitality of the maquette is assured in the enlarged piece.

The process is quite straightforward and easy to follow. In brief, it involves the reproduction of four copies of the original maquette. A network of vertical and parallel horizontal contour lines is drawn identially on all four copies. One copy is kept for reference, and the remaining three are sliced up along the various lines, and the contours thereby released are traced on paper and then enlarged either photographically, by opaque projector, or simply squaring up to the desired scale. These enlarged contours are either cut out of plywood and styrofoam, or formed in steel tubing and reassembled into the substructure of the final piece. The substructure is covered with chicken wire, and then layers of fiberglass reinforced resin are applied to form a durable case. The fine finishing is done with resin putty to correct uneveness in the forms, and then a final surface of pigmented resin is applied overall.

CHAPTER II

THE ENLARGING TECHNIQUE IN 9 STEPS

It is taken for granted that anyone who will proceed with this enlarging technique is familiar with the basic principles and methods of molding and casting. And, of course, it is assumed that they are informed about the general characteristics of the raw materials used.

Furthermore, I should like to point out that the 9 steps cover the process in general terms and deal only with the most common problems that are to be expected. It provides, however, a solid base, and once its operating principles have been understood, any complications, or modification of the method to suit a particular case can be solved simply with applied logic.

Step No. 1

9. Four copies of the original maquette, sculpture by Wolfgang Krol.

The first step is to reproduce four identical copies of the original maquette, for which a reusable mold is required. Should you have none, make a rubber, a fiberglass reinforced resin, or even plasterpiece mold of the maquette.

Cast the four copies in a rigid, non-shrinking, but easily cut material. Those qualities you will appreciate at a later stage, when three of the maquettes will be sliced up along a network of contour lines.

You have the option of two different casting methods and materials. Both are well suited for this particular purpose.

A. Make a thin-walled hollow cast in epoxy laminating resin.

B. Make a solid cast in polyurethane foam.

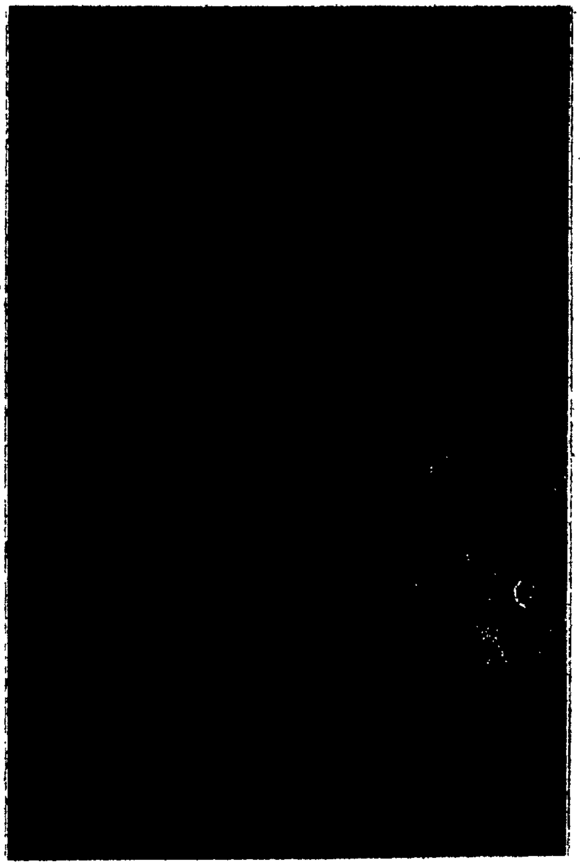
If epoxy is used, it should be of a creamy consistancy, so that it can be built up in the mold to a 3/16" thick layer. If necessary, thicken it with a filler, such as Cab-O-Sil.

Both the epoxy and the foam are commercially available, and simple to use. However, the mixing of the component chemicals must be done with a fair degree of precision.

When working with plastics, always adhere to the safety precautions suggested by the manufacturer.

Step No. 2

This step is to establish parallel horizontal contour lines, which must be drawn identically on all four copies. This job requires accuracy and the ingenuity to devise and construct some of the needed supports for the maquettes.



10. Set-up for drawing horizontal contour lines.

An adjustable tripod, a pencil, and a horizontally smooth and level surface are the basic equipment required. As it is shown in the illustration (No. 11), the lines are drawn by the pencil attached to the top of the tripod. The tripod is the ideal tool for this purpose because it is adjustable to different levels, essential for spacing the horizontals. It is stabilized with a heavy weight suspended from its legs (see illustration 10).

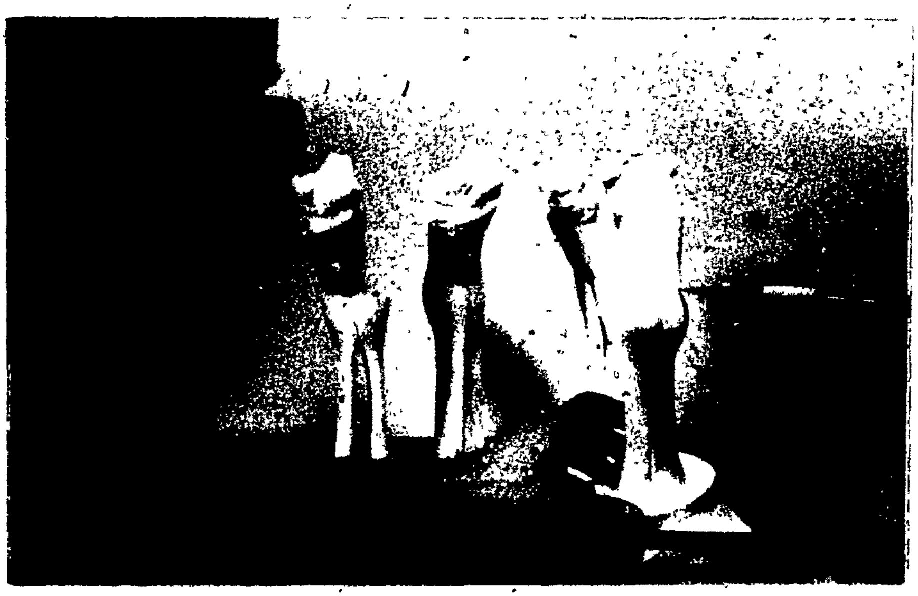
11. Drawing of parallel horizontal contour lines.

To draw the horizontals, the maquettes are placed on a perfectly level and smooth surface in contact with the tip of the pencil. When the maquette is rotated, the pencil marks a continuous horizontal contour line on it. The surface on which the maquette stands has to be smooth to allow for effortless and easy rotation. A greased piece of glass placed on a level table top works well.

While the tripod is positioned for the first horizontal, the contour has to be drawn on all four copies, one at a time. Once this has been done, the position of the next can be selected by either raising or lowering the tripod.

The location of each horizontal must be carefully chosen for the amount of information it provides with regard to the projections and recesses of the form. Contours have to be drawn throughout the full height of the maquette and numbered H_1, H_2, H_3, . . . etc. Obviously, the lines must be drawn sufficiently close together that one is never in doubt about the areas between them.

The maquette should be oriented to the level surface in such a way that the horizontal contours are as close as possible to being at right angles to the surface.

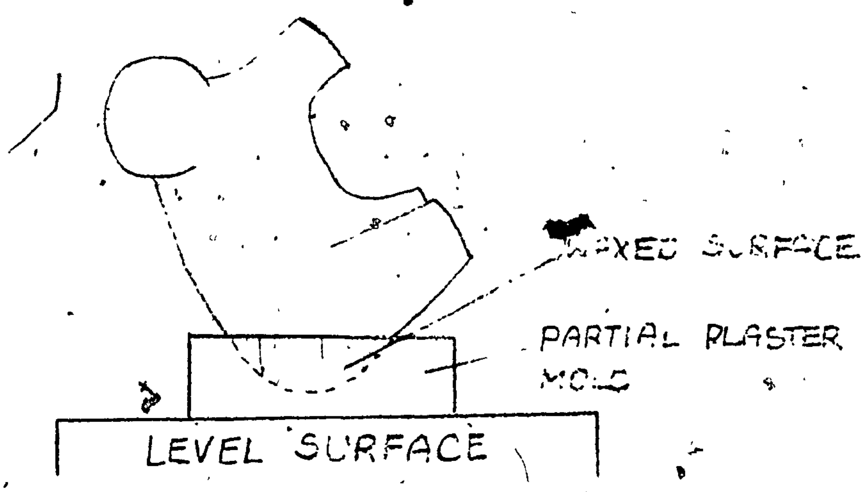


12. Positioning of maquette in front of the tripod - with the help of a wedge.

If the sculpture is self-supporting, there is no problem in placing it in front of the tripod to draw the lines. Many organic sculptures, however, will need an extra support to keep them stable in the desired position. There are many ways to solve the problem; almost as many as there are different sculptures. Sometimes just a wedge will do it (see Illustration 12), but in most cases, a more sophisticated device has to be constructed.

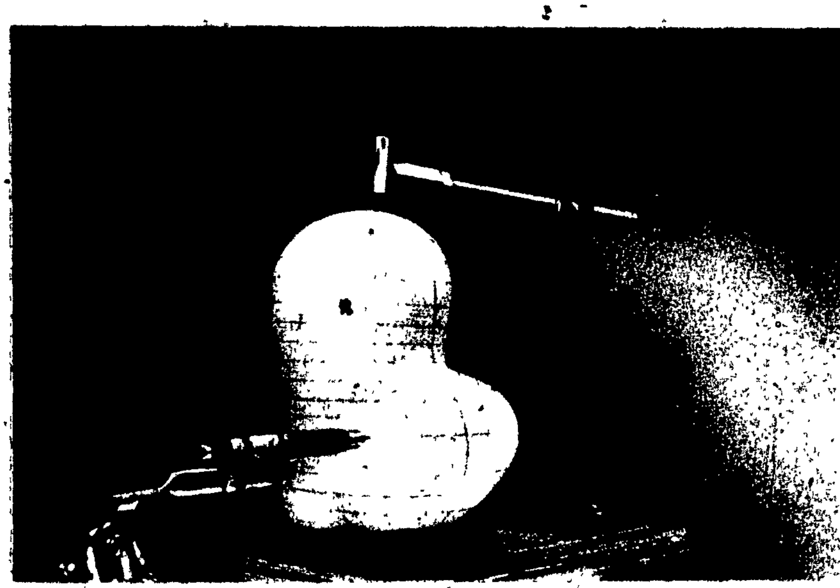
The illustration of two examples will hopefully provide some insight into the range of technical devices that can be utilized.

A reasonably simply method is to make a partial plaster mold that will support the maquette firmly in an upright position. This mold is then used as an orienting base for all four copies.



13. Partial plaster mold for positioning the maquette,

This partial plaster mold has to be made on a perfectly level surface. You proceed by pouring molding plaster into a container proportioned to the shape and size of the maquette. Once the plaster has set to a consistancy from which an impression can be made, one of the maquettes is pressed into it and carefully positioned. Remember, a mold release has to be applied to the part of the maquette which is used for molding -- in this case, any kind of wax will do. The base should be held as shallow as possible, because the surface of the maquette has to remain largely uncovered for the horizontals to be drawn on.



14. Maquette supported by a jig.

The shape of some types of sculpture is such that it may require rather more elaborate means for their support than the one described. This refers primarily to pieces of an eccentric weight distribution and predominantly rounded forms. One way to stabilize them in the desired position is to attach the maquette by its bottom with pins to a base board and the top to an external armature-like construction such as a jig (see illustration).

Step No. 3

Next, a perfectly flat central slice must be established; that is to say a contour like that which encircles the sculpture in one plane and divides the piece into a front and back. The contour of the slice should be at 90 degree angles to the horizontals. If this is not possible, the angle the central slice forms with the horizontals will have to be duplicated when the substructure is assembled.

The enlarged slice is the central support of the substructure. All verticals and horizontals will be attached to it at the stage when the substructure is assembled.

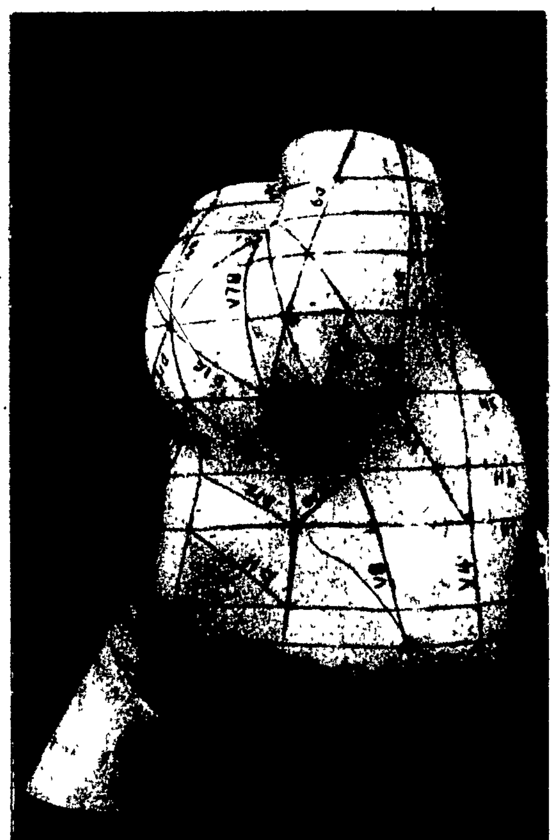
In drawing the contour line of the slice, you are confronted with problems similar to those in the previous step with the horizontals. That is, to find a method of stabilizing and positioning the maquette.

15. Drawing of central slice.

Once again, use the equipment and methods you employed in step number 2. As with the horizontals, the drawing of the contour line of the slice must be repeated on all four maquettes identically.

Step No. 4

The "vertical" contour lines are drawn next. The verticals need not be strictly parallel to each other; neither do they need to describe a closed "circle", as in the case of the horizontals - in fact, they are rarely vertical (i.e. at right angles to the horizontals). This is because, once again, they should be selected for the amount of information they provide.



16. Network of horizontals and verticals drawn on the maquette.

The main verticals are contours extending from the top of the central slice to its lower edge. Depending upon the information that is needed, some verticals may follow a diagonal direction to and even cross each other (see Illustration 16).

17. Drawing of verticals, sighting along a steel ruler.

The equipment used to draw the verticals is less mechanical than that required for the previous steps. You need only a steel ruler, a pencil, and your ability to judge a straight line by sight. The photo above illustrates the way one sights along a steel ruler to select a straight vertical line. Mark the line with points along the edge of the ruler which then are joined with a continuous line. Check the contours for absolute straightness. Any bends or uneveness will throw off the design at later stages when they are cut, traced, enlarged, and reproduced at the enlarged scale.

Number all verticals V_1, V_2, V_3, . . . etc. Draw the contours on one maquette only. They are transferred to the remaining three by means of a flexible rubber mold as outlined in step number 5.

In the case of a sculpture that changes direction, you are confronted with an additional problem in drawing the horizontal and vertical contours. This problem is solved by simply dividing the maquette into separate units at the point of the change in direction, and treating each one as a completely separate sculpture.

18. Maquette cut into separate units.

Sometimes it is necessary to actually cut such a maquette into the units; however, you may leave your maquette intact as long as it is possible to draw the level horizontals (on each unit separately) by tilting the maquette and holding it in the desired position, propped up by custom-made wedges, blocks, etc.

19. Drawing of "central" slice on one section of a maquette (destined for division at the waist) using wedge and block.

If cut, the individually treated units are joined again at the stage when the substructure is assembled.

Step No. 5

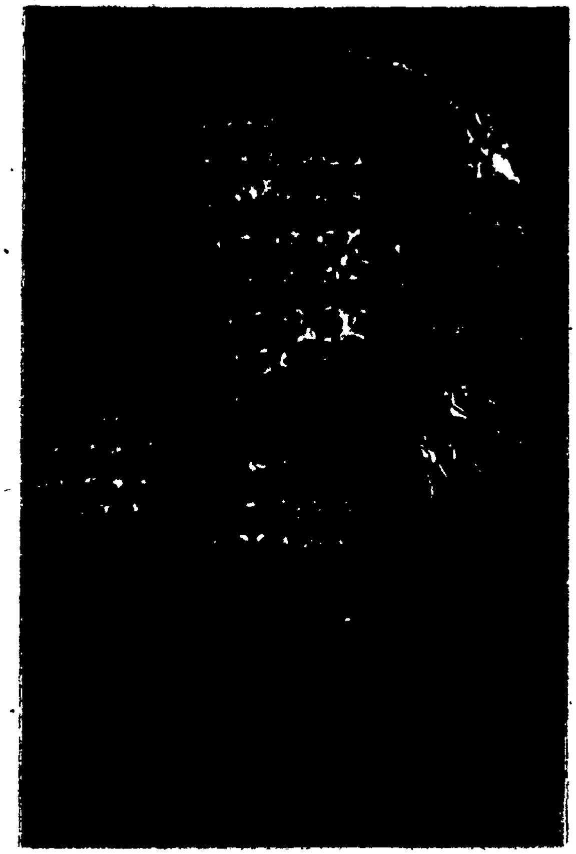
The reason for using a flexible rubber mold to transfer the vertical contours is difficult to explain in advance, but easy to understand once it has been done.

20. Maquette with pins inserted into intersections.

The first step is to drill small holes (1/16" or smaller) into the points at which verticals and horizontals intersect, and insert nails of appropriate diameter into the holes. The nails should fit tightly. In addition, drill holes at the intersections of the horizontals and central slice on all three remaining casts.

21. Silastic rubber brushed on the maquette.

Brush on a coat of silicone rubber (approximately 1/8" thick) over the full surface of the maquette and around the nails. Silicone rubber is commercially obtainable, but it is necessary to use the kind with minimal shrinkage (e.g. Dow Corning Silastic "E"). A generous coating of vaseline should be used as a separator. Again, study the instructions before use.

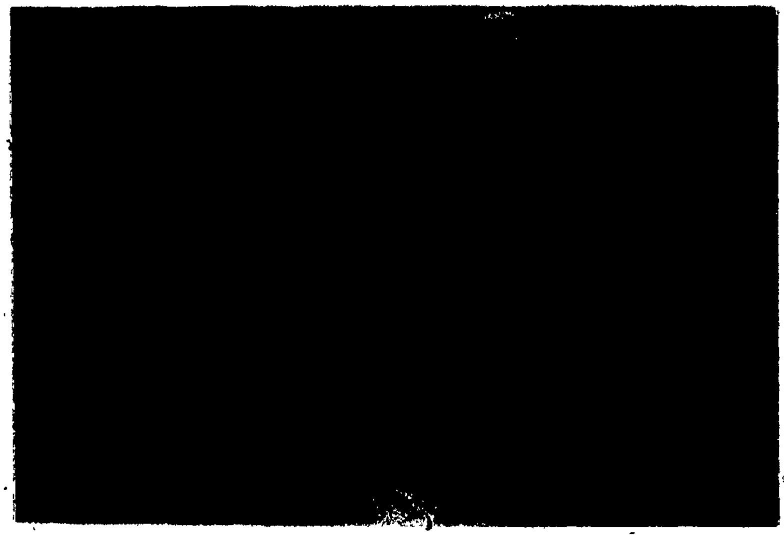


22. Cutting of seam line into the silastic mold.

Once the silicone rubber has set, a seam to remove the mold has to be cut. First pull the nails out, then with a mat knife, slice through the rubber following a slalom-like course, using the nail holes of the central slice as flag poles (see Illustration 23). The cut should not be longer than is necessary to free the sculpture.

23. Maquette with silastic mold.

Remove the mold with great care, because silastic rubber is a very fragile material which tends to tear easily. The purpose of the rubber mold will now be understandable. The nails created holes into the rubber at the points of intersection of the verticals with the horizontals. When the mold is fitted over the remaining three copies, one at a time, the intersections are transferred by pencil marks made through the holes. To ensure a proper positioning of the rubber mold, pin it to the maquettes using the already drilled holes along the contour of the central slice.



24. Removal of silastic mold following marking of intersection points.

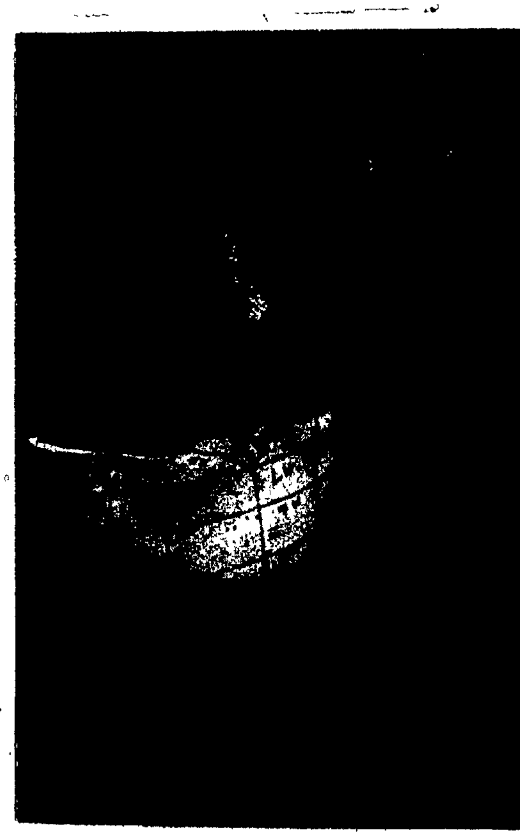
Transfer all intersections with pencil marks. Remove the mold, and trace the path of each vertical by connecting the points with a continuous line. Number them to correspond with the first copy.

It is impossible to overemphasize the importance of accuracy when drawing and tranferring contours. Infinite pains at this stage will be amply rewarded at subsequent stages.

Step No. 6

This step is the dusty job of slicing up three of the copies along the contours. The fourth is kept intact for reference. In the process of cutting the horizontals, you begin with a complete maquette which, at the end, is reduced to a pile of dust and a stack of drawings. The only equipment required is a mini-grinder with an 80 or 100 grit fibre disk. For your own safety, you must wear goggles and a mask during cutting and grinding to prevent inhaling the poisonous epoxy dust.

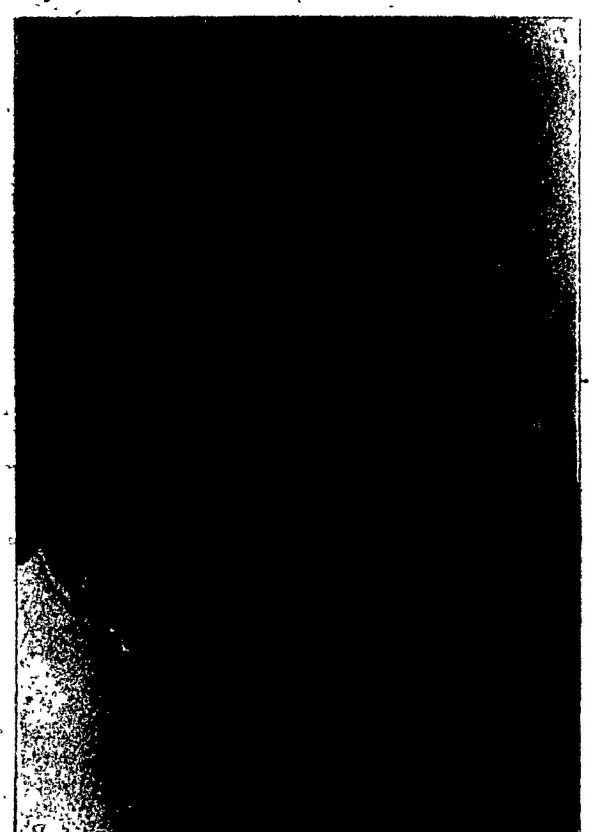
Before you begin to slice up the maquettes, you should decide on a systematic procedure, so that you do not forget any lines or waste your maquette by thoughtless cutting.



25. Cutting and grinding of a contour.

Use one of the three copies for cutting the central slice, one for the horizontals, and the third for the verticals.

An easy way to slice the maquettes accurately is to first cut with the grinding disk and the minigrinder approximately 1/8" above the drawn line and then grind the cut down, until you have arrived at the precise contour. Trace the released contour on paper and proceed to the next. Label each contour H_1, H_2, H_3, . . . etc. and mark the points where opposing lines meet (intersections) and number them accordingly.



26. Tracing of a contour line on paper.

In the case of a sculpture that changes direction and which was not cut into separate units, the central slice has to be cut at this stage. Measure the angle of the change in the direction of the central slice; that is to say, the angle in which the slices of the separate units meet. The measurement of the angle is required when the units are assembled in the enlarged scale.

Step No. 7

The traced contours will now be enlarged to the final scale. The enlarging can be done either photographically, by opaque projector, or simply by squaring up to the desired scale.

The advantage of enlarging photographically is that it is less time consuming than squaring up, and more precise than the opaque projector. To achieve accurate and precise enlarged contours, the photographic equipment (camera and projector) must contain high quality lenses in order to avoid unacceptable levels of distortions.

Take 35 mm slides of your contours. Several of them may be arranged for one slide, but where feasible, avoid placing them too close to the edges and corners of the frame. In these areas any distortions will be at their maximum.

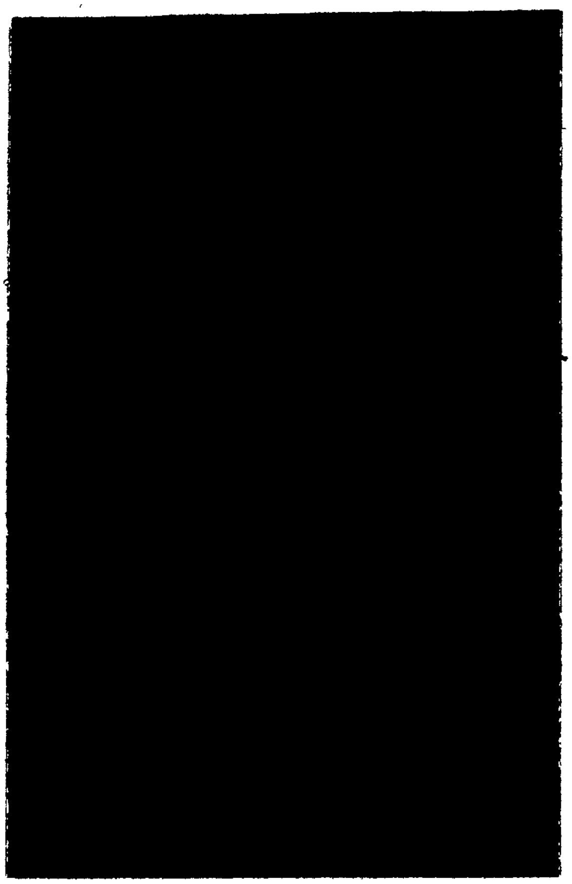
To enlarge the contours, project the slides onto a flat wall. In order to minimize distortions, the projector must be set up at right angles to the wall. The accuracy of the angle is checked by projecting a slide on which the center is marked. The distance of the central point from the four corners of the frame should be identical.

Project the contour of the central slice, and by altering the distance of the projector from the wall, the desired scale increase is achieved. If the final scale was not planned in advance, the projected image of the central slice, along with the maquette help to decide upon the most effective scale.

Once the decision has been made, project all contours and trace each one on a sheet of paper pinned or taped to the wall. Take special care in the transferring of all lines and lettering.

The method of squaring up is used either when you have no access to reliable photographic equipment or you wish to enlarge to such a monumental scale that the projection of slides is not practical. Squaring up is potentially the most distortion-free method, but only if the number of grid lines is generous and the transferring of the contours is carried out accurately.

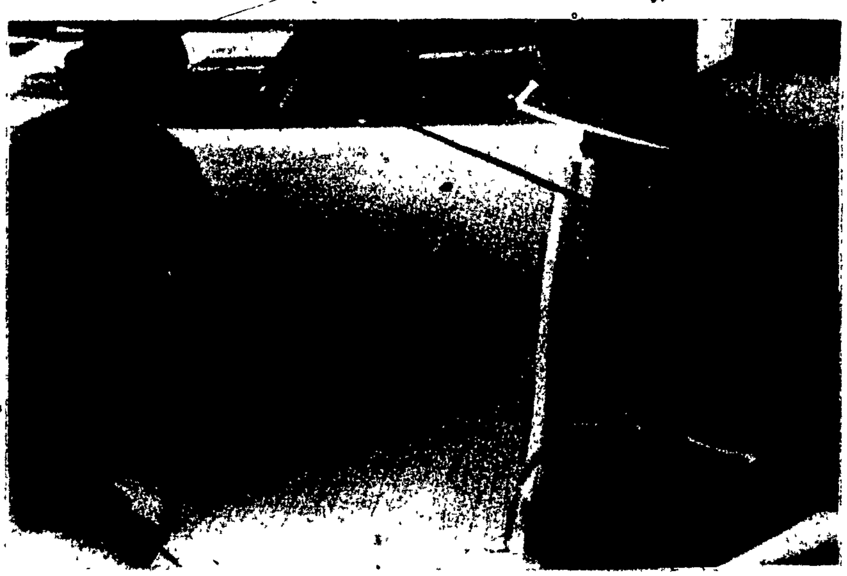
To save time, trace all contours on graph paper, and select thereon a grid small enough to ensure no difficulty will be encountered in reproducing the contours. Then draw a full-scale grid enlarged by the chosen ratio.



27. Contour traced on graph paper.

For drawing the enlarged contours you require a translucent material such as "Mylar". It is a relatively strong sheet, but translucent enough to allow the pattern of the enlarged grid to be seen through it.

The point at which each contour crosses a graph paper grid line is noted, and located on the enlarged grid. These points are now joined using a flexible curve (e.g. plexiglass strip). You may wish to draw several contours on one Mylar sheet, but you should take into consideration the fact that during the process of bending steel rods or tubing, the sheet is likely to receive rough treatment.



28. Squaring up of a contour to the enlarged scale.

Step No. 8

The heavy work begins with step number 8, as, for the first time, you are working directly on the final sculpture. Step No. 8 is to make the substructure of the final, enlarged piece. Again, you have an option.

A. To build the substructure out of plywood and slices of foam.

B. To weld hand-bent steel rods or tubing into a cage-like structure.

Your choice of one method over the other should be conditioned by such considerations as: the desired scale of the enlarged sculpture, the stress to be borne by the final piece, the funds and equipment available, and your skills.

Method A is limited by the scale of the enlarged piece. Plywood, which is required for the central slice, generally cannot be obtained in larger than 4' x 8' sheets, and although it could be joined, there is a point when it becomes impractical to work with plywood. On a very large scale, plywood becomes unmanageable and too heavy.

Consideration must be given to the overall shape of the sculpture. Should the piece have thin cross-sections that carry the weight of large forms, a steel structure may be the more suitable choice. However, there are ways of incorporating a partial steel structure bolted to the plywood slice. Method A should be used wherever possible as it is considerably faster, easier, and cheaper than Method B.

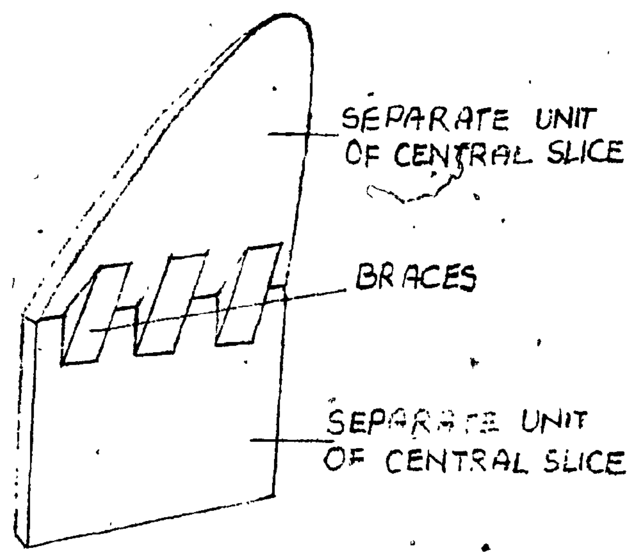
For Method B, you must have access to welding equipment and have acquired the basic skills of welding. In addition, more patience and manual skill is required by this method.

Method A

The first step is to reproduce a full-scale central slice in plywood (usually 1/2" or 5/8" thick). Trace the enlarged contour on the sheet of plywood and cut it out. Transfer all horizontal intersection marks and label them.

Plywood is used for this purpose because it has all the qualities that are essential for the central slice. It is stable and strong enough to give central support to the total piece, and to the horizontals and verticals that will be attached to it.

If the central slice consists of separate units, they are joined again at this stage. This is done with the aid of braces that are cut to the angle at which the slices meet.

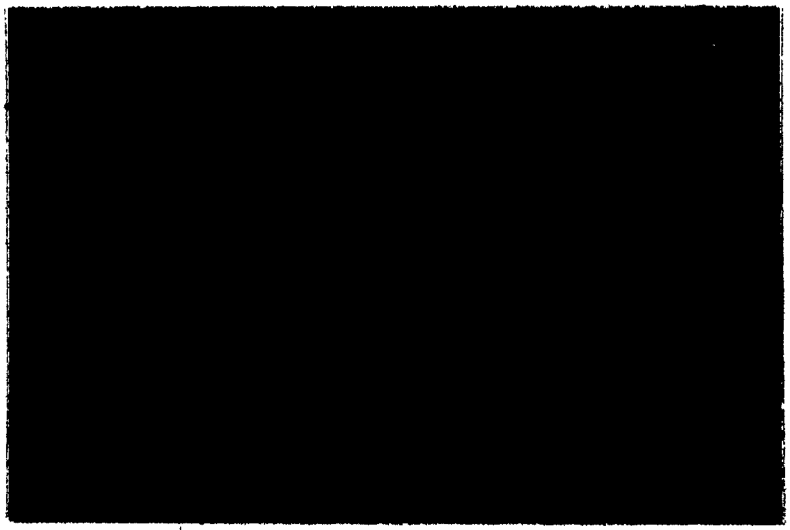


29. Joining separate units of the central slice.

Any protruding support required later to secure the sculpture to the base or at a particular angle should be bolted to the plywood slice now.

Cut all horizontal slices out of 2" styrofoam, preferably using an N. T. cutter (long bladed mat knife). Transfer all vertical intersection marks and label with care, because they are essential for assembling the substructure.

Cut all verticals in 1 1/2" wide bands out of masonite (1/8"). The illustration shows how to utilize a sheet of masonite economically. Transfer all horizontal marks and label them.



30. Cutting bands of verticals out of masonite.

Now that all parts belonging to the substructure are ready, they can be assembled in the position which their equivalents occupy in the maquette. This is done without much difficulty as long as the different contours are positioned in accordance with their correct codings.

31. Central slice with assembled horizontals.

In order to attach the horizontal foam slices to the plywood central slice, each one must be cut in two along the line joining the vertical slice (central slice) intersection marks. To prevent an alteration in the form, the thickness of the plywood has to be taken into consideration, which means that each half of every styrofoam slice must be reduced by half the plywood thickness at its central cut.

To create an extra support for the horizontal halves, drive spikes through the plywood along the lines of contact. Push the styrofoam halves onto the spikes, and using epoxy, glue them to the plywood at the correct angle (usually 90 degrees).

The vertical masonite bands are attached to the foam horizontals by sliding them into 1 1/2" slots cut in the foam at the intersection points.

32. Plywood central slice, assembled horizontals, and bands of verticals.

An efficient way to cut accurate slots is to use a circular saw blade made out of the same masonite (1/8") and fitted onto the minigrinder. The vertical bands are then assembled and glued into position with epoxy.

Method B

Whether to use rod or tubing is a decision usually conditioned by the size of the final sculpture. Rod is more suitable for very large works, as, for example, H.W. Jones' "Love", which has a steel substructure of 1/2" square steel rod, bent and welded commercially. In this case, the rod was placed on the Mylar contour sheets and shaped by a team of workmen. When the scale of the enlargement is less enormous, the work can be carried out by one person. Then tubing is used of a strength that can be bent by hand, but which must be rigid enough to hold the desired curves during the subsequent handling.

To mimic the enlarged contours in steel tubing, a flat wooden surface, a hammer, and 1 1/2" roofing nails are required. A 5/8" or 3/4" sheet of plywood, placed on a stable support or on the floor will serve the purpose.

33. Method of bending steel tubing.

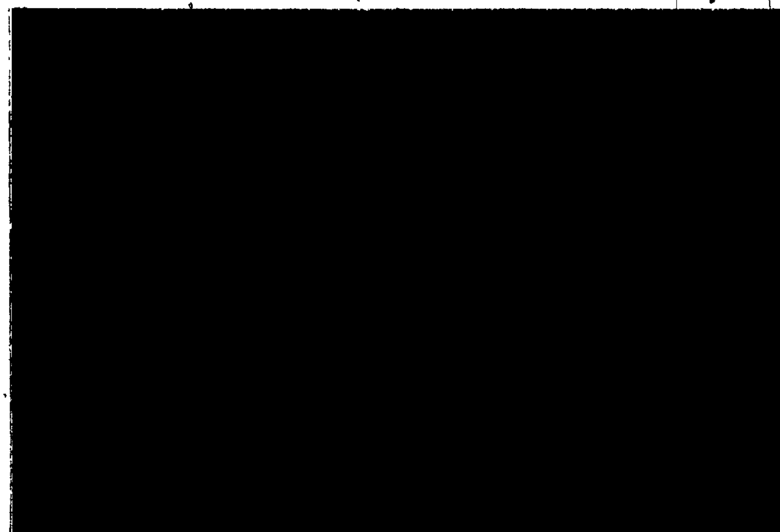
The illustration above demonstrates the method by which the tubing is bent by hand to the desired contour. You can see that the tubing is gradually pulled against the nails and thereby shaped into the enlarged contour. Roofing nails are used because of their big heads which prevent the tubing from slipping off when it is bent into shape. The shaped part is kept in position by nails hammered into the wooden surface as illustrated.

Use a file or any other sharp tool to mark the intersections and label them accordingly, using tags of masking tape.

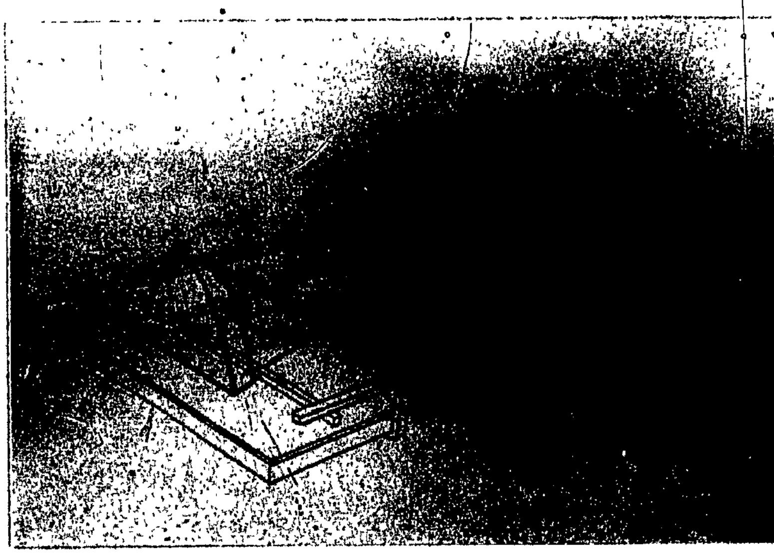
Welding of the steel substructure:

Clamp the central slide firmly to the welding table (see

Illustration 34). Again, as previously, the horizontals are cut into halves and welded, normally at right angles, to the central slice, forming a cage.



34. Contour of the central slice clamped to the welding table.

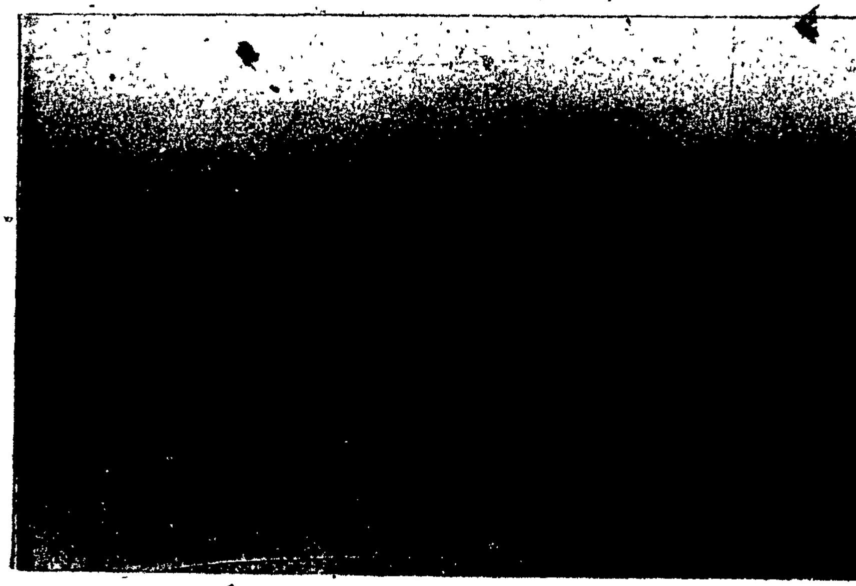


35. Horizontal halves welded to the central slice.

The verticals are welded to the cage of horizontals by the procedure explained in the illustration. Using an oxyacetylene cutting torch (or large welding tip), cut each horizontal where it intersects the path of <u>one</u> vertical only. These cuts should be as wide as the rod or tubing is thick so that the chosen vertical contour can now be properly positioned and welded into place at the intersections.

36-38. Welding of the verticals to the cage of the horizontals.

37.



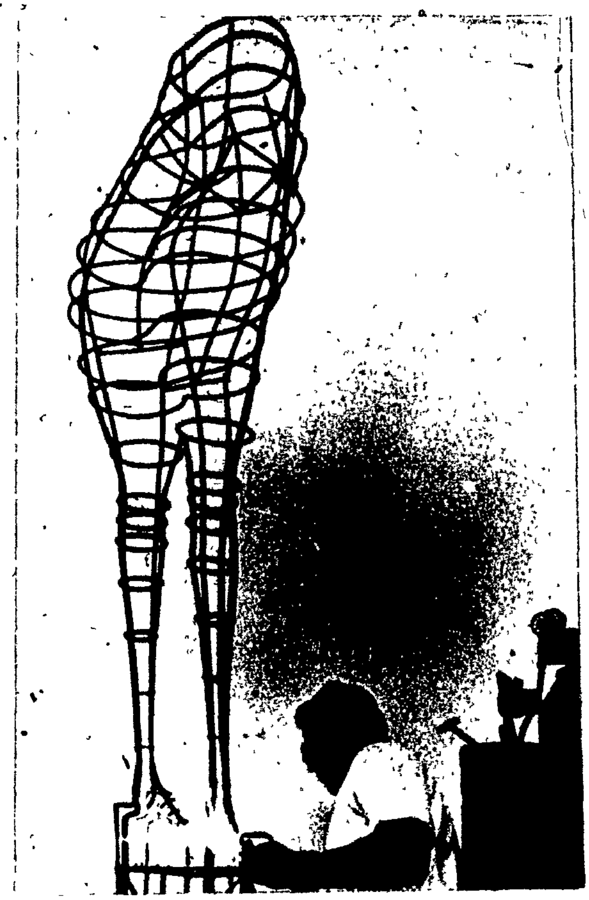
38.

Once one side of the cage is completed, turn it over and assemble and weld the other by the same method. At this stage, it is not necessary to clamp the cage to the welding table. It is now rigid and free from the danger of distortions caused by the heat of welding.

39. Welding of the second half of the cage.

If the sculpture was cut into separate units, those are joined again, once the cage of each has been completed.

The cage can be made as strong as is necessary by introducing heavy steel tubing into the inner space and joining it to the cage with welded tubing. Any protruding steel support required to secure the sculpture to the base or at a particular angle, can be welded to the cage and to any inner structure.



40. Completed steel cage.

Step No. 9

This is to cover the substructure, whether plywood and foam or a steel cage, with chicken wire and then apply fiberglass reinforced resin over all.

Before you begin fiberglassing, you should be aware of all safety precautions that are necessary to follow when working with plastics. It is becoming ever more evident that resins, along with associated catalysts, fillers, hardeners, and solvents are extremely toxic and can be absorbed by the body both through the air and by direct contact. Even relatively brief periods of exposure may have regrettable consequences years later. In industry, some serious disabilities have been reported that were caused by contact with plastics.

One should work out of doors or in a well ventilated room. It is necessary to always wear gloves and properly fitter respirator equipped with fresh filter cartridges designed to remove dust and organic vapours.

Method A .

Polyester resin dissolves styrofoam, hence the foam slices must be painted with a coat of epoxy or any other protective material.

If the spaces between the contours of verticals and horizontals are too open, perforated steel straps should be attached between the areas before the substructure is covered with chicken wire.

An efficient way of applying the chicken wire to the foam and plywood structure is to cut pieces large enough to be bent into the shape of the area it has to cover, and pin the pieces of wire to the foam with U-shaped pins (bent out of welding rod).

41. Plywood and foam substructure covered with chicken wire, steel straps, and partially with fiberglass reinforced polyester resin.

Cut fiberglass mat into squares of a workable size. Saturate the squares thoroughly with polyester resin and apply them to the cage of chicken wire with the edges overlapping. Work out all air bubbles with a brush and additional resin. The thickness of the fiberglass coat (the number of layers to be applied) is conditioned by various factors: the kind of substructure, the size of the piece, and its purpose.

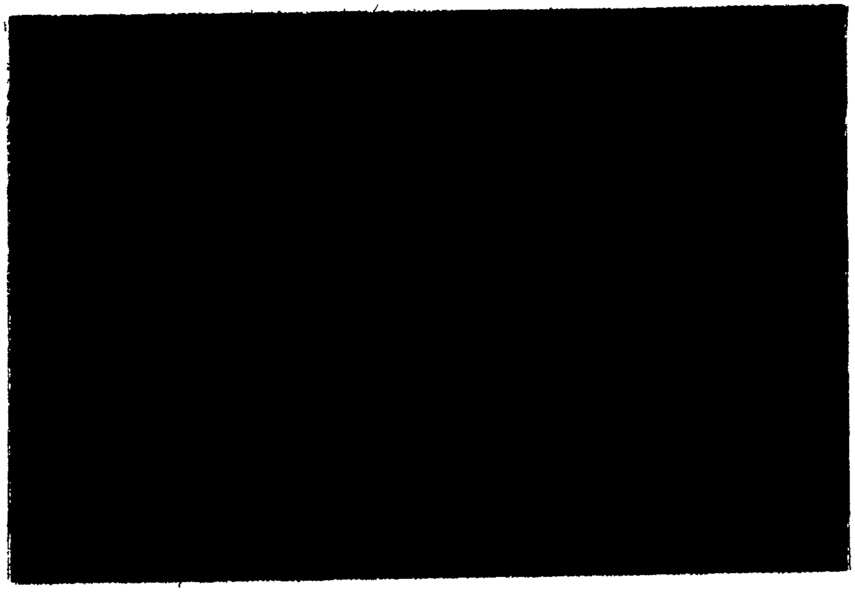
If the substructure is plywood and foam, the strength of the sculpture depends solely on the thickness of the fiberglass skin. Scale is another determining factor; the larger the piece is, the stronger the fiberglassing must be. Furthermore, an outdoor sculpture has to stand up to greater stress than one placed indoors and consequently must be made more durable.

Method B

For covering the substructure with chicken wire and fiberglassing it, the same procedure as in Method A is applied.

42. Steel cage covered with chicken wire and perforated steel straps.

The next step is to correct inaccuracies in the surface of the fiberglass skin with polyester car putty. Use the putty to build up areas that are low, and to smooth out the overall surface. Follow the instructions for mixing and application carefully, so that setting time, final strength, and surface quality are acceptable.



43. Application of polyester putty.

For the final finishing, the desired result determines the kind of tools that have to be used. I will suggest only a few. You may prefer others and work out alternative techniques that are better suited for the particular surface quality you wish to achieve.

A half round and flat surform rasp are excellent tools to use for correcting and smoothing the surface. Rasp the putty as soon as it has set to a flexible and still soft consistency. This is the brief period before it turns rigid and stone hard. You should apply the putty in patches small enough to permit you to keep up with the rasping. The putty is best applied with a plastic spatula designed for the purpose.

By now, the process of enlarging is almost completed. The final step is the application and refinement of the outer surface. There are a variety of finishes possible, ranging from a rough and unpolished surface, different textures, to something smooth and shiny. You will probably wish to get away from the grey shades of the putty. One alternative is to spray or paint the sculpture with commercial car paints, enamel, lacquer, or or acrylic. Or, you may prefer to treat the surface with pigmented resin. If so, roll on about four coats with an ordinary paint roller. Although this is an efficient way, it results in an orange skin texture which you may not particularly care for. If you aim for a smooth and polished finish, sand the surface with wet/dry carborundum paper. Start with an 80 grit and sand your way up to 600. Hand sanding is tedious, time- and energy-consuming, but it has the advantage of greater control and eliminates the risk of sanding through the pigmented coats. It is possible to save time by applying more coats of resin (8 or 10) and using an electric disc-sander in the early sanding stages. If desired, buff the surface with a rubbing compound and wax it to protect the finish.

The enlargement is completed.

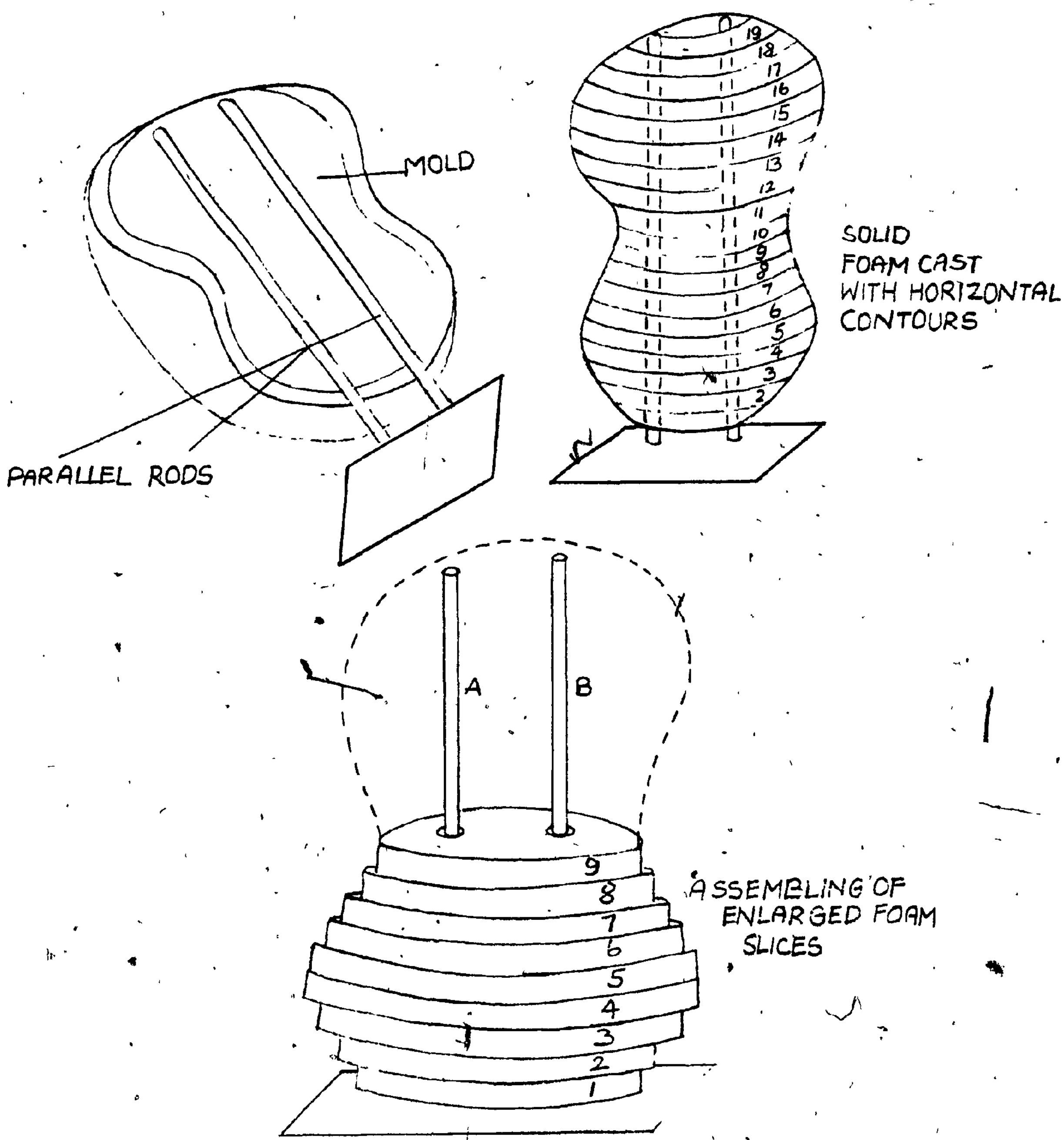
44. Maquette and enlarged sculpture by Monika Braham.

CHAPTER III

VARIATIONS ON THE TECHNIQUE

The subject technique was specifically developed for the purpose of finding a more economical system of enlarging sculpture by working directly in the final material. It is, however, possible to utilize the technique indirectly by applying plaster on the chicken wire cage of the substructure instead of fiberglassing it. A mold could then be made in the traditional way and the piece cast finally in bronze, resin, cement, etc. If the sculptor wishes to make changes on the form at full size scale, fewer contours may be used. Then the substructure merely supplies the major proportions of the sculpture, leaving ample space for bending the chicken wire in at some areas or out at others, with further refinements still possible at the plaster stage.

Other variations of the basic approach will suggest themselves as one becomes familiar with the process. One possibility which is only suitable for medium-sized sculpture is an enlargement in solid foam. The piece could then be modified at will, covered with either plaster for subsequent molding and casting, or with fiberglass and putty, etc., as already described. In the latter case, a protective coat of epoxy must be applied before fiberglassing.



45. Construction of substructure for enlarging medium-sized sculpture in solid foam.

This variation requires only one reproduction of the original maquette, and further differs from the basic method in that it utilizes only horizontal contours. The copy is cast in solid urethane foam in a mold containing two parallel steel bars (see Illustration 45). Horizontals are drawn on the maquette at such a distance to each other that they will be 2" apart on the enlarged piece. As before, the maquette is sliced up along the contour lines which are traced, labelled, and emlarged, including the location of the holes left by the rods. The enlarged horizontals are cut in 2" styrofoam slices with the holes punched out. The full scale slices are then slid in the correct order onto two properly spaced parallel bars. The sculpture is completed by the method already described.

CHAPTER IV

CONCLUSION

This then constitutes the first documentation of a relatively recent invention of a system by which to enlarge non-geometric forms. The advantages of the system were tested numerous times by sculptors who had adapted its techniques and the successfully enlarges works testify that the system is reliable.

I think it is necessary to note that the instructions were deliberately made simple and concise in order to assure a clear comprehension of the system. Yet, at the same time, great care was taken not to exclude aspects which could present the inexperienced with insurmountable problems. The relative simplicity, accessibility, and directness of this technique should not, however, lead one to underestimate the time, energy, and perserverance required to successfully enlarge the type of sculpture for which it was designed.

Once a sculptor has been confronted with a commission which necessitates the enlarging of a sculpture involving forms that are of a non-geometric character, only then will he/she fully understand why the subject technique is invaluable.

The commission of a large sculpture almost invariably begins with the submission of a maquette. In some instances, the client may be sufficiently enlightened to accept proportional changes between the maquette and the final enlarged piece. A sculptor however, who can create in a small scale for maximum effect at a larger dimension, will be clearly at a considerable advantage when equipped with the subject technique.

Effective changes to non-geometric forms at full scale are incredibly difficult to achieve, because alterations must be made on the work, whereas it will be viewed at an entirely different distance and angle. This unavoidably results in a "trial and error" approach, with great increase in time and energy expended.

The meeting of deadlines, which is common to commissions, is an additional burden the artist has to take into consideration, and, because "time is money", the cost of the production in such a case is much less predictable.

The sculptor who is working with the subject technique has the guarantee that the enlarging will result in the exact reproduction of the maquette in a larger scale. Besides this advantage, he may also enjoy the benefits of additionally lowered production costs, by working directly with fiberglass reinforced resin as the final material. Considerable savings are realized by not having to get involved in the process of mold making and casting. And again, if the scale increase of the sculpture is not too great, one can proceed unaided and consequently more economies result. In the case of a commission based on aesthetic considerations and a fixed remuneration (e.g. a competition), this will increase considerably the potential earnings.

For the sculptor or student who has no guaranteed commercial justification for enlarging, I can only report that, whereas I have found the experience of enlarging enormously rewarding, it involves a great deal of essentially non-creative effort.

There is an undeniable excitement and a sense of accomplishment associated with the production of a large scale sculpture, but it must be weighed against the similar rewards of a more creative activity.

The subject technique affords the artist great control over the resulting work, but the amount of time and effort inevitably involved requires that I end this thesis with the recommendation that only one's best work, specifically designed for increased scale, even be considered for enlargement.

FOOTNOTES

[1] John Ivor Smith, lecture at the University of Victoria, February, 1972.

[2] Jacques Lipchitz, My Life in Sculpture. New York: The Viking Press, 1970, pp. 217-218.

[3] E. Iversen, Canon and Proportions in Egyptian Art. London: 1955.

[4] Ernst Mackay, "Proportions on Tombwalls in the Theban Necropolis", Journal of Egyptian Archaeology, IV, 1917, pp. 74-85.

[5] Gisela Richter, The Sculpture and Sculptors of the Greek. New Haven and London: Yale University Press, 1970.

[6] Art and Technology. Suzannah Doehringer, David Gordon Mitten, Arthur Steinberg (eds.) Cambridge, Mass.: The MIT Press, 1969, p. 254.

[7] Pantograph machine, Colas machine, Robert Payne machine, Reul Type machine, Scopas Enlarger by John Tiranti.

BIBLIOGRAPHY

Adam, S. The techniques of Greek sculpture. London: Thames and Hudson, 1966.

Art and technology. Doehringer, S., Mitten, D. G., Steinberg, A. (eds.) Cambridge, Massachusetts: The MIT Press, 1969.

Desroches-Noblecourt, C. Ancient Egypt. Greenwich, Connecticut: New York Graphic Society, 1960.

Iversen, E. Canon and proportions in Egyptian art. London: 1955.

Jagger, S. Modelling and sculpture in the making. New York: The Studio Publications Inc., 1933.

Lipchitz, J. My life in sculpture. New York: The Viking Press, 1970.

McCann, M. Health hazards manual for artists. New York: The Foundation for the Community of Artists, 1975.

Mackay, E. Proportions on tombwalls in the Theban necropolis, Journal of Egyptian Archaeology, IV, 1917.

Miller, A. Tradition in sculpture. London and New York: The Studio Publications, 1949.

Page, A. Egyptian sculpture, Archaic to Saite. Westminster, Wilshire, England: Avis and Phillips Ltd., Teddington House, 1976.

Rich, J. C. The materials and methods of sculpture. New York: Oxford University Press, 1966.

Richter, G. The sculpture and sculptors of the Greek. New Haven and London: Yale University Press, 1970.