# THE USE OF HORIZONTAL, VERTICAL, AND CONTOUR LAMINATION TO THE SCULPTURAL FORM

PROBLEM IN LIEU OF THESIS

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# CHAPTER I

## INTRODUCTION

With the advent of modern technology and the development of new industrial techniques, wood is today emerging in an infinite variety of forms. For centuries wood has been associated with construction, folk art, decoration, and utilitarian objects. Ancient and primitive people carved idols as well as serving vessels from wood. Fifteenth and Sixteenth Century Italian and German woodcutters created intricate, beautiful altarpieces. Early American carvings were of weather vanes, ships' figures, utensils, and equipment for domestic and industrial use.

Today the sculptor is exploiting the potential of wood to create works that exhibit pent-up energy, power, and an intense expressiveness independent of the objects they may represent.

Until the middle of the 1700's when adhesives came into use, all woodwork was dry-jointed with pegs. Today white emulsion glues such as casein and acrylic resin are most popular for wood that is to be kept indoors. They dry clear and are very strong, but they are not waterproof. If color is desired around a glue line, these water-base emulsion glues may be tinted with acrylic paints. Casein glue is

especially good for bonding oily wood such as teak and pitch pine. It can be mixed with sawdust to form a wood putty that will match the color and texture of the wood.

Waterproof glue should be used on sculptures to be placed outdoors. Epoxy resin or resorcin resin glues are so dependable underwater that they are used for boat hulls.

Due to the wide variety of lamination techniques, two opposing philosophies about craftsmanship in wood sculpture have occurred. The skilled craftsman believes in perfect joints carefully prepared, glued, and smoothed. The other method, termed anticraftsmanship, is aimed at breaking down tradition. The anticraftsman may use wood haphazardly, permit dowels to protrude that are uneven, and allow glue to drip and run at imperfectly formed joints.

## Statement of Problem

In sculpture I have dealt primarily with wood. Initially I dealt with laminating boards one inch in thickness into a solid block, or when short of money using logs from the surrounding area. I soon realized how restricting it was to be confined to this limited space, or a solid block or log, in carrying out my ideas, and the need of an alternative to expand my ideas.

The purpose of this problem was to investigate the advantages and possible limitations of horizontal, vertical, and contour laminating to the sculptural form. Specific

questions were set forth to help determine the different aspects of these types of lamination. The specific questions for which answers were sought are as follow.

1. How complex a design can be executed by the laminating process?
2. How close to the design will the initial lamination be?
3. What are the best methods of lamination for each process: types of clamps, types of wood, types of glue, dowels and weights?
4. How successful may these lamination techniques be combined?
5. As the work was in progress, which became more important--the surface quality or the form?
6. Will laminated forms remain stable?

## Limitations of the Study

The lamination techniques were limited to laminating one inch boards, with close dimensions to the sculpture design. Five sculptures were laminated to ascertain the advantages and possible limitations of laminating wood to the sculptural form. The designs for the sculptures were to become more complex throughout the investigation, to push the possibilities of lamination. The sculptural designs were to be in keeping with the type of craftsmanship I have done previous to this investigation. All sculptures were limited to indoors and water-base glue was used.

## Procedures

To carry out this investigation, five sculptures were laminated to experiment with horizontal, vertical, and contour lamination. The different designs of the sculptures caused a wide range of situations to laminate. C-clamps were used in areas under ten inches in thickness; bar clamps were used in thicker areas. In situations where contour forms would not allow the clamps a good grip, tire inner tube cut into strips were wrapped around the boards to be laminated. For situations where clamping was too awkward for a good bond, quick drying epoxy resin was used.

The basic tools needed in this study were: a band saw for cutting lumber as close to the shape as possible, a grinder with 16 grit grinding disc for rough shaping, one inch U-gouge and mallet if a concave shape was desired where the grinder would not be able to reach, rasp and rifflers for finer shaping, and various grades of sandpaper from a course 60 grit to an extra fine 600 grit.

## CHAPTER II

## THE INVESTIGATION

Five pieces were constructed to explore the possibilities of laminating wood to the sculptural form. A series of slides and notes were kept to record progress and the results of horizontal, vertical, and contour lamination. Six questions were considered while working on each piece and noted when applicable.

"Untitled" #1

The goal of this first sculpture was to design a simple form by horizontal lamination, without deviating too far from my previous sculptures. The design is a narrow wedge shape twenty inches long with an eight inch wedge laminated on the bottom toward the front of the piece for balance. Both wedge shapes have contours giving a flowing transition from one form to the other. This design was simple enough to use a grinder on all parts for roughing out the form.

1. How complex a design can be executed by lamination?

Horizontal lamination worked well for stacking boards to provide height in the sculpture, but not much lateral movement could be achieved except for staggering the mahogany boards in the necessary direction. To achieve a good

lamination, the boards could be staggered only gradually to achieve an even distribution of C-clamps. Less complex shapes lend themselves to horizontal lamination, although more complex areas of the piece could be carved to achieve more complexity.

2. How close to the design will the initial lamination be?

With horizontal lamination it was easy to visualize the design, similar to the design of a topography map, by stacking shapes cut out with the band saw. This process seemed easiest to laminate close to the less complex sculptural form.

3. What are the best methods of lamination for each process: types of wood, types of clamps, types of glue, dowels, and weights?

When laminating areas under ten inches thick, C-clamps were used with deep throated C-clamps for wider areas. Areas over ten inches thick were clamped with bar clamps or weighted down with slabs of limestone or marble when staggering of the boards was desired. Dowels were usually necessary to avoid slippage before the glue dried. When laminating irregular shapes, band clamps or tire inner tubes were used to clamp securely. In case an area needed to be staggered sharply, it had to be laminated in sections of a few boards at a time. When laminating sections that could not be secured by a clamp, quick drying epoxy resin was used. The epoxy resin does not require clamping. Both surfaces should be coated evenly and held

together for five minutes. Occasionally for heavier sections, a few extra minutes of drying was allowed, since the epoxy does not reach maximum strength for an hour. On this piece mahogany was used which lended itself to a good bond. Open pores on the surface allows glue to soak in.

4. How successful may these lamination techniques be combined?

It was apparent that with the use of epoxy resin combining these techniques would allow more freedom. End grain on a long vertical section was cut at the desired angle to match flush with the horizontal section. Contour lamination allows curves much easier than staggering boards in the desired motion. These techniques were interchanged whenever most advantageous. Stress points were considered in the piece since horizontal extensions were too week and required the strength of the grain running lengthwise; therefore, laminating vertically allowed the most strength.

5. As the work was in progress, which became more important--the surface quality or the form?

Since mahogany has an open grain and is a medium hard wood, it does not get as smooth a finish as harder, close grained wood; but it still was sanded to a fine finish. On this horizontal work much end grain was exposed and this made finishing a little more difficult. The form was the primary concern and arriving at the desired form is what exposed more end grain.

6. Will laminated forms remain stable?

Since the sculpture was intended for indoors, Pax bond or Elmer's carpenter glue worked fine on an open grain wood such as mahogany. The glue line on a more porous wood is stronger than the wood itself. There were no stress points on the sculpture which may have required epoxy resin. Danish oil finish was used to coat and protect the sculpture from the expansion and contraction wood experiences with changes in the weather.

This design was easily laminated to the desired form, but did not amount to much of a challenge. Without the negative and concave shapes in the piece, it amounted to a learning experience.

"Ocena II" #2

After the simple design of the first sculpture, I wanted to experiment with contour lamination to achieve the negative and concave shapes I was accustomed to when carving logs. Hopefully, with contour lamination it would be possible to achieve a flowing, undulating rhythm. The design had two opposing concave curves blending together to achieve a balance between the two curves. A small wax model was made to determine the balance point of the design.

1. How complex a design can be executed by contour lamination?

Contour lamination is the most difficult process, but it allowed more freedom than horizontal or vertical lamination.

A variety of curves were created by laminating different size wedges to direct the type curve needed. Jigs were clamped down on a band saw as a type of template used as a guide into the blade to achieve the degree of angle needed. As in Slide #1 dowels were important when laminating wedges to prevent slipping. For sharper curves which were cantilevered, an epoxy resin glue was used. On this piece Paduak wood was used for its rich color and grain. The wood was hard and brittle, with an oily close grain which made it more difficult to get a good bondage since the oil hinders glue from soaking into the pores of an already tight grain. Benzoil was used to remove oil from the wood to allow better lamination.

2. How close to the design will the initial lamination be?

Contour lamination can achieve close dimensions to the form. To allow the full curve of the contour, extra boards were laminated to the outer curve (Slide #2) so hollow areas of the inner curve could be achieved by carving. The curves in this piece were intentionally laminated overly thick to allow a fluid transition of form by carving.

3. What are the best methods of lamination for each process: types of wood, types of clamps, types of glue, dowels, and weights?

Large C-clamps worked well for laminating several wedges at once as in Slide #3 provided they were doweled together.

Any pressure on the wedges forced the center wedges out unless doweled. Mahogany would have been better for this type of contour lamination than the paduak. The lighter, more porous mahogany allows more freedom; the paduak became restrictive if pushed too far in a thin or cantilevered shape. The epoxy resin helped resolve the stress problem or structural weakness. It also helped in obtaining a flush glue line. When cutting wedge shapes on the band saw, even with a jig, the angles were slightly off at times. The epoxy resin was coated to each glue surface making up for any gaps or slight warpage of boards. Weights were not too practical for gluing the curves. Band clamps, strips of inner tube, or epoxy resin in place of carpenter's glue were used for more difficult areas of lamination.

4. How successful may these laminating techniques be combined?

After completing a curve with contour lamination, a vertical or horizontal extension could be added before going into another curve. The use of vertical or horizontal extensions added a great deal of freedom with the direction of the design desired.

5. As the work was in progress, which became more important--the surface quality or the form?

The form was the primary concern of this piece, but the hard close grain also allowed a fine finish to be achieved. The rich color and rich tight grain pattern allowed for an

interesting interaction between the interplay of grain with the interplay of convex and concave forms. For a surface to work as evenly as the form, a hard wood with pronounced but not coarse grain should be used. These include black walnut, American elm, paduak, rosewood, teak, and a variety of other exotic hard wood. For finishing, Watco Danish oil was used after sanding to at least 200-grit sandpaper; and to highlight certain areas, sanding with 400- or 600-grit sandpaper was used. After the first coat was rubbed in and allowed to soak for about an hour, a second and third coat may be repeated like the first coat to achieve maximum protection with the oil. Lemon oil was later used to add lustre to the sculpture and restore moisture to the wood which has a tendency to dry out over the years.

6. Will laminated forms remain stable?

On this particular piece the extension which holds the balance for the sculpture receives the most stress. Epoxy resin was used in what was considered to be the crucial areas of this particular curve. This sculpture was intended for indoors, so epoxy resin at all glue lines was not necessary for this piece.

This process was considerably more time consuming than the previous sculpture, but the extra time I spent was well worth it. The balance of the piece was well executed. The blending of the two concave curves worked well to make this

sculpture more interesting than the simple design of the first sculpture.

"Untitled" #3

The purpose of this design was to achieve quality lamination on a much larger scale. This piece was made over seven feet tall to determine if there would be any stress problems due to the weight of the piece. To achieve this height, it was necessary for it to be a vertical linear form with leg-like forms to get the main body of the sculpture three feet off the ground. There was a horizontal extension with a vertical blade-like shape at the end of this extension to balance off the piece.

1. How complex a design can be executed by combining horizontal and vertical lamination?

On this sculpture larger scale was considered as a possible limitation. By using leg-like forms as in Slide #4 vertically laminated, the main body of the sculpture was soon lifted three feet off the ground as in Slide #5 and stacked horizontally to achieve a height of seven feet four inches. By combining vertical and horizontal lamination, the sculpture could have easily been made several feet taller. Mahogany, being a light weight, durable, and porous grain for good bonding, lends itself to larger size scale sculptures. The combining also allowed for laminating a more complex form since there was equal freedom vertically and horizontally.

Laminating thicker areas by either method helped in carving a more elaborate design.

2. How close to the design will the initial lamination be?

The combining of vertical and horizontal laminations allows more freedom to achieve closer dimensions to the form. When laminating a vertical extension to a horizontal section, or vice-versa, extra dimension in the wood next to the glue line, as in Slide #6, was necessary to allow an even transition from one section to another. This transition was achieved by carving and grinding with a surform rasp.

3. What are the best methods of lamination for each process: types of wood, types of clamps, types of glue, dowels, and weights?

Bar clamps, C-clamps, and weights were used for horizontal and vertical lamination. For laminating the part of the main body of the sculpture that meets the legs, weights were used. Since this covered a large surface area and the boards showed practically no warpage, linestone slabs were stacked on the glued boards for a secure lamination. C-clamps were used in smaller areas as in Slide #7. Where thicknesses were less than ten inches, three-quarter dowels were used when connecting legs to the main body of the sculpture and epoxy resin was used to insure maximum strength. Again, mahogany was used for its lightness, durability, and porousity for making strong glue lines. This sculpture was done in

three main parts--the first part, the legs; second, the main body of the work; and the top portion of the sculpture. All the boards laminated in each section required only Elmer's carpenter glue. After the three sections were shaped, there was no easy way of getting a good grip with any of the clamps. Thus, epoxy resin was necessary to make the final lamination connecting the three sections.

4. How successful may these lamination techniques be combined?

Noted on a piece of this size, vertical lamination with the grain running lengthwise is particularly important for supporting a good deal of weight.

5. As the work was in progress, which became more important--the surface quality or the form?

As in all the sculptures up to this point, the form was more important than the surface quality. But the surface was also important, or I would have used a cheaper grade of lumber such as white pine or cedar.

6. Will laminated forms remain stable?

This sculpture, since it weighs over two hundred pounds, provided a test for the stability of this lamination technique. The area which receives the most weight was doweled together with epoxy resin and has not shown any signs of weakening.

The size of this piece presented a different kind of challenge than the second sculpture, however, it presented

no problems. The sculpture is structurally sound with the design working well. The extension worked well to play against the rest of the sculpture.

"Ola II" #4

This design was worked out to give more of a variety in thickness. It has a large, rounded form tapering to a point on the bottom with an extension at an angle from the side of this form tapering to a point. The top of this rounded form tapers into a long curve upward for approximately two feet, then curves downward opposite the extension to create a three point, balanced form. To determine the balance of this piece, a wax model was made.

1. How complex a design can be executed by vertical lamination?

Vertical lamination is similar to horizontal lamination in the amount of movement to be achieved. As with horizontal lamination, lateral movement can be achieved by staggering boards in the desired direction. Vertical lamination has more grain running lengthwise, so forms can be extended farther without becoming structurally weak.

2. How close to the design will the initial lamination be?

Since the boards were laminated vertically, it was somewhat harder to visualize the boards fitting into the design as easily as horizontal lamination. If staggering the boards

is done gradually and there are no sharp curves within the design, close dimensions can be achieved.

3. What are the best methods of lamination for each process: types of wood, types of clamps, types of glue, dowels, and weights?

This process is similar to the horizontal lamination except that the grain was run lengthwise to obtain height instead of stacking boards. On this piece bar clamps were not necessary. Eight-inch and ten-inch C-clamps were used throughout the piece except for one extension which was difficult to get a clamp to hold due to its curved surface. Epoxy resin which dries in five minutes was used. For this glue joint, dowels were used. In this case, the dowels were not for strength, but to hold the extension in a precise position.

5. As the work was in progress, which became more important--the surface quality or the form?

The form was the primary concern but with vertical lamination more side grain is exposed than end grain such as in horizontal lamination. The side grain is easier to sand, has a more interesting grain pattern, and makes for a smoother finish than end grain. With concave and convex forms, the vertical lamination creates more interesting grain patterns.

6. Will laminated forms remain stable?

This sculpture is less than three feet tall which eliminates practically all stress on any area. The area that might receive a little tension is the longer extension, since it holds the balance of the piece. Realizing ahead that this was the most crucial area, epoxy resin was used. This sculpture was intended for indoors.

The balance of this piece worked out well, giving it plenty of stability. The large rounded form worked well with the slender concave curve giving an interesting transition which accelerated the movement of the form as it curved downward into a sharp taper.

"Ola III" #5

With this sculpture, the design was to achieve a feeling of centrifugal force, spinning two concave curves off from the central form in opposite directions. The tips of each curve do not rest on the pedestal, giving a feeling of continuing movement. The concave area on the longer extension accentuates the movement of this sculpture along the tapering of both extensions.

2. How close to the design will the initial lamination be?

Due to the simplicity of the design, close dimensions were easily obtained. With vertical lamination on this piece, little carving was required; most of the shaping was

done with an electric grinder. Subtleties were achieved with a convex shaped surform rasp and hand scrapers.

3. What are the best methods of lamination for each process: types of clamps, types of wood, types of glue, dowels and weights?

Mahogany was used for its open grain and workability. C-clamps were used throughout the piece since there were no areas over ten inches in thickness. The sculpture was laminated in two parts, and these two sections were bonded with epoxy resin.

5. As the work was in progress, which became more important--the surface quality or the form?

As in all of the sculptures done in this investigation, the form became more important than the surface. This piece exposed more side grain than end grain. The side grain allows for a better surface since the end grain has a tendency to be rougher and absorb more oil, leaving a dry surface until eventually saturated with oil.

Laminating the one inch thick mahogany boards lengthwise allowed strength for the two curved extensions to support the massive central form. The centrifugal motion of this piece allowed it to be positioned in several different ways, giving it a look of a different sculpture at each viewing.

# CHAPTER III

## SUMMARY AND CONCLUSIONS

By working with these lamination techniques, I believe I will be able to expand upon the direction I have been heading in sculpture. These techniques separately or combined add many more possibilities in designing sculpture. The sculptures can be extended in any direction in space, instead of a more contained mass, stifled by the restricted space of a log.

The areas of exploration in this series of work dealt with the following points:

"Untitled" #1 helped in learning the fundamentals of lamination. Although it was only an experiment with horizontal lamination, I learned how to use the C-clamps effectively for getting a good bond throughout the sculpture. The simplicity of this sculpture only required C-clamps which made me consider a more complex sculpture to experiment with different lamination techniques.

"Ocena II" #2 was more challenging than the previous sculpture. The contour lamination required wedges, which were blocks of wood cut at an angle to achieve the desired contour. These wedges required dowels to prevent slippage when laminated. Although this sculpture was more difficult

to laminate, the extra effort allowed more freedom to create a more flowing complex sculpture.

The large scale of "Untitled" #3 presented a different problem. This sculpture was seven feet four inches in height, which tested the stability of laminating vertically and horizontally. For strength the leg-like forms were laminated vertically which allowed the grain to run lengthwise. The strength of the mahogany wood and the Elmer's carpenter glue proved that it is possible to laminate a sculpture of this size.

"Ola II" #4 was designed to experiment laminating a sculpture with varying thicknesses. The large bulbous form which tapered to a point, was laminated with bar clamps in the thick areas and C-clamps in thin areas. The use of bar clamps allowed the freedom to vary the thickness as much as desired without sacrificing any strength of glue lines.

The purpose of "Ola III" #5 was similar to the intentions of "Ola II" #4 except that the idea of varying thickness was accentuated more with this design. The movement of this sculpture was enhanced by the contrast of the massive center of the sculpture with two extensions tapering to a point in opposite directions.

The most difficulty in this investigation was finding a way to clamp the wedge shapes on contour lamination. C-clamps were effective up to ten inches in width. After that, bar clamps were used when possible. Due to the bar

clamps occasionally slipping, tire inner tube was used to wrap around wedges to insure a good bond.

In obtaining close dimensions to the sculptural design, wax models were constructed. These models were very helpful in visualizing the design from all angles and in determining the balance point of the design. By seeing the design from all angles it was easier to plan out the lamination, such as the angle the boards should be cut, the transition of forms from one area of the sculpture to another, or possibly changing the design after observing from all angles.

Research into what type of wood used, should be done to determine how oily and close the grain is. Oily tight grain wood such as paduak is difficult to get a good bond with since the glue does not absorb into the pores of the wood. To avoid this problem, mahogany was used on four of the five sculptures in this investigation for its dry open grain, which allows a much better bond.

The weight of the wood should also be considered if any forms are to be extended in space. To find out about weight, density, split resistance, and other properties of wood, a wood selection chart is available in Contemporary Art with Wood by Dona Z. Meilach.

# APPENDIX

# BIBLIOGRAPHY

## Books

Meilach, Dona Z., Contemporary Art With Wood, New York, Crown Publishing Company, 1968.