Clamping 2.0 - Thoughts about clamps and clamping

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Introduction

Clamping is one of the most used techniques and processes in the conservation of wooden objects and furniture. It is the method employed to bring broken, loose, or delaminating parts back together in a manner that is risk-free, durable and re-workable. Examples requiring clamping can range from large, complicated joined structures to small bits of veneer. Furniture conservators are faced with such problems as clamping down marquetry on straight and curved surfaces, loose veneer spanning large cabinet doors or re-assembling structurally unstable chairs, tables and cabinets. Central questions are: How do we select the right clamp from a large inventory of clamps and associated support materials, and how do we adapt our knowledge when faced with a complex intersection of surfaces compounded by very fragile wooden structures and sensitive coatings? This article describes clamp types and methods and gives examples of creative solutions and adaptations.

Figure 1 Tripod table with broken top.

Definition

The definition of a clamp is: a device used to bring separate pieces together with as much pressure as required for a sufficiently reliable bond according to the parameters of the adhesive used. The following example out of the conservation practice illustrates the complexity of a clamping task. A candle stand top was broken (private collection). A previous restorer had repaired a different break and glued the whole top to the pedestal plate, which meant the top could not be removed (figure 1). The top broke many years later in a different place. The setup required a pair of parallel cauls top and bottom to ensure exact alignment of the broken piece, shaped, soft self-supporting cauls to locate pressure on the rim without damaging it, and risers to supply spacing and a secure resting place for the clamps. Mylar tape was used to isolate the parallel cauls from glue, and a soft material for the rim caul to protect the shaped surface (figure 2). The logistics and setup took most of the project time whereas the actual gluing with fish glue was a very small part of the process.

This simple project shows that clamping is a process, not just a single activity. The individual steps of the clamping process included:

- Assessing the fit of the break.
- Making jigs and fixtures.
- Choosing an adhesive.
- Selecting appropriate clamps and applying pressure.
- Ensuring protection from bumps and glue.

Fit

The initial step in the process is to assess the breakage and the fit of the pieces. The following considerations are important:

- Is the break new or old?
- Are the breakage surfaces irregular but clean fitting?
- Are there losses to the break surfaces that could compromise the strength?

Figure 2 Tripod table clamping setup.

- Is the break located in a purely decorative feature or at a vital structural element?
- Is the breakage so smooth that it might slide easily during the clamping process?

A break can be self-regulating and easy to put back together or it can be more difficult to precisely align the parts, and thus the process may need additional consideration and subsequent support. Many other specific considerations might need to be made depending on the individual object.

Jigs and fixtures

Jigs and fixtures are frequently necessary in order to stabilize the object, register and align edges, and provide off-object clamping points. This may involve the use of cleats, wedges, leveling devices, counterpressure, or other aids to ensure level and even surfaces, thus allowing the practitioner to undertake the clamping operation in an organized, risk-free way.

Choice of glue

The issue of adhesive choice is too complex to address here, but the kind of adhesive chosen will depend on the nature of the break and will influence the choice of clamps, the preventive protocol, and the logistics. The conservator will need to appreciate properties like open time and gap-filling abilities as well as appropriate pressure in order to identify the best material.

Applying pressure

The choice of clamp and clamping pressure needed must be adjusted to the density of the materials and the state of degradation.[1] Pressure needs to be applied without causing distortion or damage to the adherents until the adhesives are sufficiently cured. This is especially important in situations where there is a potential for shear or shifting under pressure. Anticipating the required pressure and planning the distribution is crucial for a successful joint. Rivers and Umney approximate the expected pressure of various clamping tools in a table.[2] The amount of pressure needed is hard to measure and is mostly judged by experience and feel. However, Winkelsen conducted standardized bending fracture tests and on the basis of that developed a practical guide for calculating the respective concentration of glues and the clamping pressure and the resulting bond strength of re-gluing fractures perpendicular to the wood grain.[3] Cases for which an epoxy system is chosen do not necessarily need continuously applied pressure. Traditional

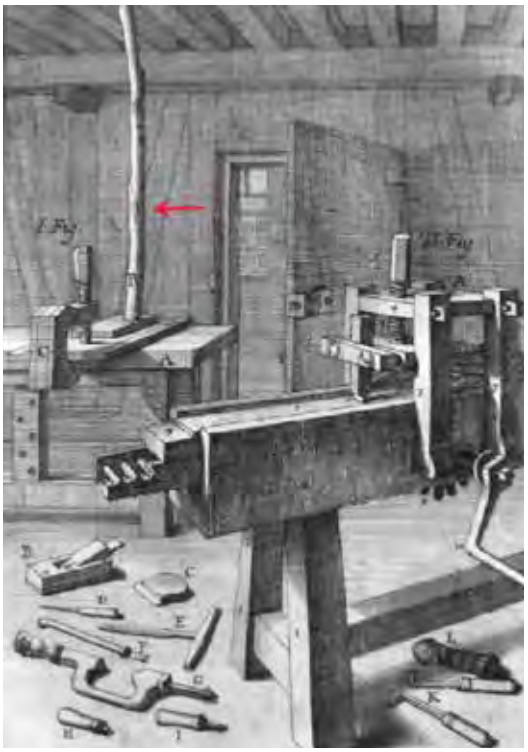

Figure 3 Illustration from Félibien's '*Des principes*' .

rub joints and hammer veneering, where pieces have a smooth surface and a tight fit, do not need a clamp at all, as the gelling characteristics of hot animal glue will suffice to keep the joint together.[4]

Cauls and protection

In most cases cauls or clamping blocks are needed to target or to evenly distribute pressure. This can be achieved with rigid cauls for flat surfaces, curved cauls for curved surfaces, or soft cauls for uneven surfaces.

Flat cauls can be of any firm material: wood, plywood, medium-density fiberboard (MDF), tempered hardboard (Masonite-type), and cellulose-based fiber board (Homasote) are common. Very useful are see-through cauls made of acrylic sheet (Plexiglas/Perspex). These have the advantage of being flexible, depending on thickness, and allow one to observe the squeeze out of the glue.

Flat cauls lined with metal sheets allow for heating the caul surface and hence prolonging the open time of hot animal glue when used for re-adhering lifting marquetry.

Curved cauls can be made from a number of materials. Wooden cauls can be cut to match the shape of the object. Kerfed plywood, bending plywood ("wiggle wood", Flexply), or thin acrylic sheet is very useful for relatively even curves. Closed-cell polyethylene foam (Ethafoam) is easy and fast to shape and can provide the necessary rigidity of the caul. This can be increased by adding thin plywood. Sandbags can be used to conform to curved or more complex, uneven surfaces. They have the advantage

Figure 4 Circular discs with off-center screw fixture.

Figure 5 Cam-action toggles on bombe chest with marquetry.

Figure 6 Tourniquet clamp.

Figure 7 Glass bottles with lead shot.

Figure 8 Spring clamps made from upholstery springs.

of being heatable on a hot plate or in the microwave for use with hot animal glue. They can be used in combination with thin plywood or acrylic sheet or strips for even distribution of pressure.

Other possibilities include the use of thermal setting compounds such as Plastimake or two-component dental silicone that sets within minutes. These can be especially helpful to protect and secure molded or carved parts back to a carcass, as well as to take on-site where unknown configurations may require small, custom-shaped cauls.

Cauls are also often lined with a softer material, both for protection and to accommodate slightly irregular surfaces. This can be anything from silicone impregnated release paper and polyethylene sheets (Volara, Plastazote), to cork, soft veneer and balsa wood. They generally serve several purposes: they protect the object from surface damage, they can help distribute the pressure applied onto a surface, and they can keep the clamp from shifting. Care must be taken, as some softening materials such as leather or rubber can contain oils or other chemicals that can leach under pressure. An additional isolating layer of polyester film (Mylar) should be used to protect the object and the clamp from glue. This is especially important when using ferric clamps on oak as they can cause staining when in contact with such woods that contain tannic acid. Some conservators like to use non-woven polyester release fabric (Hollytex, Remay, Bondina) as an additional interface layer that prevents glue collection on sensitive varnished surfaces.[5]

Kinds of clamps

Generally, clamps fall into a small number of categories with pressure being delivered by means of threaded rods, cams, wedges, springs, ratchets, clutches, friction, compression, and so forth. Traditional wood-working clamps include hand screws, C-clamps, pipe or bar clamps, spring clamps, and band clamps. Pressure can also be delivered by weights, magnets, vacuum and other pneumatic devices. The methods and materials are only limited by the creativity of the practitioner.

Hand screws are traditional clamps (for example made by Jorgensen) with wood jaws and a double threaded rod system of tightening. Their design, updated long ago, allows parallel and non-parallel shapes to be clamped. They can also be used for pinpoint pressure. One advantage is their relatively large bearing surface. A disadvantage is that they can be heavy and unwieldy to use.

C-clamps have a threaded rod to apply pressure and a swivel cap to reduce damage to the surface

and to allow for small angles. They literally come in all sizes. Made from iron or other metals, such as aluminum, they can be very light as well as strong and produce enough pressure suitable for the job at hand. In the larger sizes, the iron clamps can get heavy. Modified versions are made for edge gluing.

Pipe or bar clamps. As the name suggests, pipe clamps are built on lengths of round metal pipe, while bar clamps are built with I-beam, rectangular bar stock, or sometimes wood. Both are generally supplied with a fixed end and a thread-driven sliding end. The sliding end allows rapid use, unlike hand screws and C-clamps which must be pre-set to avoid a lot of twisting and turning during use. Pipe clamps do not have a deep reach. They are frequently used for gluing up casework and tabletops and can generate very high pressures. Pipe clamps can be virtually any length, as one can always add more pipes.

On the other end of the scale, there is a unique, very gentle, friction operating pipe-type clamp by Berna made with a carbon fiber rod and silicone padded polycarbonate plastic jaws.

Bar clamps are probably the most commonly used clamps for furniture conservators. They are made in large sizes down to very small. Pressure is applied by screw, leverage against sliding plates, or cam action. They can be heavy to very light duty with deep to small throats. They can be very sensitive and are capable of delivering a broad range of pressures. Many of these clamps, including pipe clamps, can be reconfigured to become spreaders. Quality clamps are manufactured by companies like Bessey, Klemmsia, Irwin or DeWalt. A new system re-invented and optimized by Jiří Bém is a bar clamp that can be reconfigured as a spreader, may be added onto other clamps, and allows for very precise pressure setting.[6]

Spring clamps can be spring actuated or be springs themselves. They are generally not adjustable, though some, including shop-made versions, can be adjusted by bending in advance to apply more or less pressure. Included in this category are shim-bari, goberge, and go-bars or similar assemblies of wood, fiberglass, or other materials.

Band clamps can be used for round, square, or irregularly shaped assemblies. Simple tourniquets, where flexible loops are tightened, can be made from a variety of materials. Commercial band clamps typically have a heavy woven tape, the ends of which are gathered up by a ratcheting mechanism that tightens the loop. Stretch tape, rubber bands, stretchable wax film (Parafilm) or shrink wrap may be considered in this context.

Figure 9 Spring clamps sliced from PVC piping.

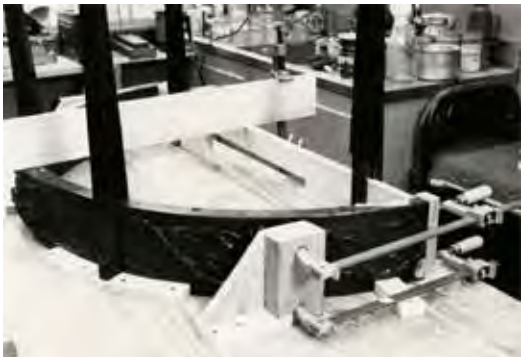

Figure 10 Demi-lune table in clamps.

Figure 11 Console table before treatment.

Figure 12 Gluing a shear break on a serpentine leg.

Figure 13 Using band and bar clamps for reassembling console table.

Figure 14 Chateau-sur-Mer painted ceiling collapse.

Figure 15 Jacks secure unstable ceiling.

Figure 16 Shimbari frame with wooden go-bars to register fragments during reassembly.

Figure 17 Fragments adhered together, back side.

Magnets such as strong earth magnets are used in many conservation disciplines. They are especially useful for thin substrates such as musical instruments, where they can be placed on either side of thin soundboards, for instance. In her publication on mounting systems Spicer recently published a comprehensive guide on the properties and the behavior of magnets.[7]

Vacuum clamping is accomplished by sealing the object or an area of the object in plastic sheeting and removing the air with the help of a pump, thus creating pressure. An advantage of this method over other methods is the creation of a very even surface pressure, both on flat and curved surfaces. Storti at the Museum of Fine Arts, Boston, experimented with readymade kits from the skateboarding community [8] for vacuum veneering a replacement panel for a table with mirror (1977.567).[9] Though vacuum pressing has been used for a long time in industry, it has only been employed for conservation under certain circumstances. In the conservation field it seems to be a method ideal for applying pressure to fairly robust surfaces, like parquetry flooring and very uneven surfaces such as Boulle marquetry.[10] Bartold developed a spindle press system that achieves compression with vacuum technology to be applied to veneered floors or walls.[11]

Conservators get much inspiration from simple historical methods, such as illustrated in Félibien[12] (figure 3), as well as contemporary conservation literature exploring the possibilities of boxes and rigs made for shimbari work for lacquer consolidation[13], clamping setups used for panel paintings, and the beautiful clamps and clamping setups used by instrument makers.

Favorite solutions

Cam-action

A letter rack required pressure for which there was no suitable clamp. A cam-action fixture was made that incorporated round plywood discs fastened off-center. By rotating the discs, they are creating a wedge-like pressure (figure 4). Likewise, shop-made cam-action levers work in concert with non-stretchy mason's twine to bring pressure to the curved surface of this bombe cabinet (figure 5).

Strings and weights

Simple strings are great where an object just needs to be held in place during the short time the glue dries or cures. In combination with a toothpick and a little tourniquet action it can be a very useful tool (figure 6).

Glasses or bags filled with lead shot are useful, too, especially in hard-to-reach areas (figure 7).
Low-tech clamps can be easily made of clothespins, barrettes, sections of upholstery spring (figure 8) or PVC pipe (figure 9).
All of these tools can be combined, customized and accessorized using additional wedges, threaded rod, cams etc., depending upon the needs of the job and the reach of the practitioner's imagination.

Examples

Demi-lune table: Collection The Preservation Society of Newport County (PSNC)
Here is one solution to the problem of clamping to a curved surface; in this case for gluing a new, dovetailed back rail into the curved apron of the table. On a plywood base, curved blocks supply firm support at the table perimeter. Blocks were created to receive the heads of the clamps and a notched caul was made for setting the dovetails. A wooden beam supplies downward pressure to counteract the lifting pressure of the clamps (figure 10).

Gilded console table: Rosecliff, PSNC

A gilded console table sustained severe structural damage (figure 11). Each of the broken front legs was glued using a small armature to hold it in place without slipping during the glue-up (figure 12). A large support was built to ensure the stability of the table and its pieces and to provide clamping surfaces while reassembling and re-adhering the legs. Bar clamps, band clamps, a tourniquet, as well as closed-cell polyethylene foam wedges for fine adjustment were used. Several sessions of dry-fitting and testing preceded the glue-up to ensure proper seating of all joints. The glue-up involved three people and proceeded in an organized manner without surprises (figure 13).

Painted plaster ceiling: Chateau-sur-Mer, PSNC
While this project was not about wood, it did inform many later projects. A section of a painted ceiling was discovered to have collapsed (figure 14). Fragments were collected and areas of the compromised ceiling was supported with jacks (figure 15). The fragments were puzzled back together and small, manageable units were identified. The individual units were reassembled by registering the flat side down and using go-bars to hold all the pieces in place while consolidation took place (figure 16 and figure 17), followed by filling surface losses and inpainting (figure 18). Once all the smaller units were complete, they were sequentially placed in the ceiling. Rails, shims and screws were

Figure 19 Applying pressure to new cast ornament with custom-made clamping setup.

Figure 20 Registration holes for go-bars.

Figure 21 Earth magnets holding staves in place during hide glue curing.

Figure 18 After inpainting.

Figure 22 Clamping table setup with bridges allowing targeted pressure.

Figure 23 Reconfigured mini-bar-clamp used as a spreader/go-bar on clamping table.

Figure 24 Adjustable counter support for lacquer panel.

used during installation to ensure all the joins were level. Then adhesive was injected from the floor above. After filling and inpainting the seams, the ceiling was secure and complete.

Cassone: Marble House, PSNC

A gilded cassone required compensation for lost gilding as well as decorative elements. New decorative elements were cast and glued in place. Here the weight of the cassone provided the backstop for a floating go-bar system used to attach the new material. Fingers were cut in pieces of plywood, which acted as springs when attached to the worktable (figure 19). Holes were drilled in the face so sticks could be seated that would hold the decorative pieces in place (figure 20). Pressure was adjusted by moving the cassone, adding packing at the surface, or moving the sticks up or down a hole or two. The compensation material was securely held while the adhesive, fish glue, dried.

Chitterone: Kingscote, PSNC

A chitterone, a lute-like instrument, was conserved by an outside contractor. The instrument had a broken soundboard and many splits in the main body. After the soundboard was removed, the staves were accessible for re-gluing. Two stacked magnets were used on each side of the body to bring together the 2 mm thin staves for gluing (figure 21).

Lacquer panels: The Elms, PSNC

The primary task with this conservation project was the consolidation of severely damaged and delaminating lacquer on three eighteenth-century Chinese export lacquer panels. A major challenge was the size of the panels (305 cm x 211 cm), which made access to the locations of lifting and lost lacquer and the application of pressure especially difficult. Inspiration for a practical solution was gained from panel painting tables and shimbari frames. An open-framework table was designed and equipped with large, moveable cross bars that allowed the clamps to be placed anywhere onto the surface. Seen to the right of the table, an organized mobile workstation with gluing materials and clamps at hand proved extremely useful (figure 22). Lifting lacquer was humidified to make it flexible, then hot hide glue was added, re-warmed as necessary with a hot bag of steel shot, then clamped with polyethylene film protection as an interface layer, rubber softening for irregularities, and an acrylic sheet caul. For applying pressure, a shimbari/spreader was fabricated. A small grip lock bar clamp was reconfigured by cutting it up, converting it to be a

spreader, and inserting the bar into a slotted piece of wood (figure 23). Similarly, larger clamps were modified to make counter-supports to place under the relatively thin panel when applying pressure to the surface (figure 24).

Conclusion

Clamping is a carefully considered process governed by the nature of the object, characteristics of the adhesive, choice of clamps and clamping devices, protection of object surfaces, and, finally, delivery of pressure. Reviewing of the work of other specialties for inspiration and taking advantage of the cleverness of others will help guide the clamping process. Clamping will always be an arena for endless creativity within the conservation community.

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Notes

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Commercial Products

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