Creating Steel Mounts for the Exhibition of Totem Poles

James Hay

Journal of the Canadian Association for Conservation (J. CAC), Volume 36

J.CAC is a peer reviewed journal published annually by the Canadian Association for Conservation of Cultural Property (CAC), 207 Bank Street, Suite 419, Ottawa, ON K2P 2N2, Canada; Tel.: (613) 231-3977; Fax: (613) 231-4406; E-mail: coordinator@cac-accr.com; Web site: http://www.cac-accr.ca.

Journal de l'Association canadienne pour la conservation et la restauration (J. ACCR), Volume 36

Le *J.ACCR* est un journal révisé par des pairs qui est publié annuellement par l'Association canadienne pour la conservation et la restauration des biens culturels (ACCR), 207, rue Bank, Ottawa (Ontario) K2P 2N2, Canada; Téléphone : (613) 231-3977 ; Télécopieur : (613) 231-4406; Adresse électronique : coordinator@cac-accr.com; Site Web : http://www.cac-accr.ca.

Creating Steel Mounts for the Exhibition of Totem Poles

James Hay

Senior Conservator, Canadian Conservation Institute, 1030 Innes Road, Ottawa, Ontario, K1A 0M5; james.hay@pch.gc.ca

The challenge of vertically displaying a deteriorated totem pole has provoked a number of solutions over the last hundred years. At the Canadian Museum of Civilization, the collaboration between a civil engineer, a steel fabricator/welder, and a conservator resulted in a mount design custom made to fit each pole to which it is attached with lag screws. The mount consists of three parts: 1) a concrete plinth, which contains threaded steel rods, 2) a steel base plate, drilled to accept the rods, while hex nuts fasten the plate to the rods, and 3) a steel mast welded to the base plate custom built to suit the artwork. With modifications appropriate for exposure to weather, the method works indoors or out. This mount design has several advantages, even for a new pole: handling of the pole can cease once the mount is attached, and the operation of erecting the pole is simplified. Risk is minimized, as a civil engineer can approve such a solution. General details of the mount structure and lifting harness are described and illustrated.

L'exposition verticale d'un mât totémique détérioré est un défi pour lequel de nombreuses solutions ont été proposées depuis cent ans. Au Musée canadien des civilisations, le fruit de la collaboration entre un ingénieur civil, un aciériste-soudeur et un restaurateur est un support conçu sur mesure pour chaque mât totémique, et fixé par des vis tire-fond. Le support est constitué de trois éléments : 1) une plinthe en béton qui contient des tiges d'acier filetées ; 2) un socle en acier, percé pour recevoir les tiges et maintenu par des écrous hexagonaux ; 3) une armature en acier soudée au socle, faite sur mesure pour s'adapter au relief du mât. Ce type de support peut fonctionner en intérieur comme en extérieur, avec les modifications appropriées pour résister aux intempéries. Le support présente plusieurs avantages, même pour un mât totémique fait de bois neuf: les manipulations directes du mât peuvent être évitées après avoir fixé l'armature, et l'érection du mât est simplifiée. Les risques sont réduits au minimum étant donné qu'un ingénieur civil peut approuver une telle solution. Les détails généraux de la structure du support et du harnais de levage sont décrits et illustrés dans cet article.

Manuscript received September 2010; revised manuscript received December 2010

Introduction

Before the 20th century, free-standing West Coast crest or 'totem' poles were erected outdoors by placing the bottom part into a hole in the ground and backfilling the hole around it. The buried part was typically about one-fifth of the overall length of the pole. While Western Red Cedar is remarkably resistant to deterioration, the lower portion of many historic poles in museum collections is either badly damaged by rot, or it is entirely absent. It is a considerable challenge for conservators to arrange vertical display, in a museum setting, of degraded, monumental wooden sculptures such as these.

Different methods have been used to mount totem poles for exhibition, either indoors or outdoors.[1] Poles have been bolted to columns or walls, lowered into a pit filled with concrete, or bolted to a wooden or metal mast which has been cast into a concrete mass. In some cases the mount has not contributed to preservation of the poles, particularly those installed outdoors. **Figure 1** shows the base of the Hunt family pole in Montreal that had been erected by lowering into concrete. After 40 years of outdoor display, the wood at the core is soft and rotten even as the exterior is not visibly damaged.

This article describes a versatile mounting system designed by a steel fabricator/welder and a conservator in consultation with a civil engineer, for both indoor and outdoor display of totem poles. It has been used for poles indoors at the Canadian Museum of Civilization (CMC) in Gatineau, Quebec, and outdoors at Rideau Hall, the residence of the Governor General of Canada in Ottawa, and at the National Museum of the American Indian in Washington, D.C. This mounting method is relatively inexpensive to construct, reasonably simple to design and install, aesthetically unobtrusive, sturdy, reliable, and enduring. Furthermore, it allows for vertical adjustment of the sculpture a few degrees left or right, backwards or forwards after installation to best achieve a vertical appearance.

The Steel Mount

The mounting system consists of three parts: a steel mount or mast to which the pole is screwed, which is welded to a steel base plate which is in turn bolted to a concrete pad (**Figure 2**). It is important to stress that public safety requirements must be met whenever a tall, heavy sculpture is erected in a public place. It is essential to consult a licensed civil engineer to ensure that the planning and work are done competently and in accordance with relevant safety regulations.

The Concrete Pad

The concrete pad is the first component of the mount and provides an attachment point for the metal base plate (**Figure 2, A**). A civil engineer should establish specifications for the strength of the concrete pad, including such details as slump,[2] soil resistance (if the pole is being installed outdoors), and thickness of the pad. Particular expertise in geology is required of the engineer if the totem pole is to be installed over bedrock or unstable river delta in a high risk earthquake zone.

Weight distribution on the floor is a fundamental consideration when placing a heavy weight inside or outside a building. The concrete pad fulfills the very important function of spreading the load created by the pole and its mount over enough surface area so that the floor can support the weight. Normally floors in Canada are designed to carry 1.9 kilopascals (40 lbs/ft^2) inside a house, or 4.8 kilopascals (100 lbs/ft^2) or more in a commercial building.[3] The density of Western Red Cedar or "thuja plicata" is 288 to 400 kg/m^3 (18 to 25 lbs/ft^3). A typical half section pole of size 5.5 m tall and 1.1 m wide (about 18 ft by 3.5 ft) will weigh about 900 kg (2000 lb). If such a pole, plus the weight of a steel mast and base plate, are to be supported on a floor that supports 4.8 kilopascals (100 lbs/ft^2), then the weight must be spread over at least 1.8 square meters (20 ft^2) of floor surface. The concrete pad could then be, for example, 1.6 m wide by 1.2 m deep (5 ft by 4 ft). If an indoor installation requires that the pole be placed against a wall, the front to rear dimension of the pad might be limited to 0.9 m or so (3 ft), meaning that its width would have to be at least 2.1 m (6 ft, 8 in) to provide the required 1.8 square metres of floor surface. Spreading the load by increasing the floor area under the pad is normally less expensive than reinforcing the building structure to support the concentrated load.

Metal rods are set into the concrete pad to provide points to which the base plate will be attached (**Figure 2, B**). Normally of 12.7 mm (½ in) threaded steel, these rods can be inserted into the pad either before or after the concrete is poured. Bent sideways at the bottom to make an "L" or "J" shape, the threaded rod can be set precisely into place in the pad form and the concrete poured to trap the rods in place. For an indoor installation, this is the least messy option, as it avoids drilling and the consequent concrete dust. It is critical, however, to ensure that the attaching rods are held precisely in place, vertical and parallel, or later the base plate will not be able to be lowered onto them. One sure way to ensure proper alignment is to fasten the rods through the holes in the base plate, hold the base plate in position in place above the pad, and pour the concrete beneath it using a ramp or hose to direct the pour. A variation of this method is to fasten the rods to a full scale plywood template of the base plate, suspend that over the pad about to be cast, and pour the concrete beneath the template. A plywood template will naturally be a lot lighter and easier to manipulate than a 12.7 mm (½ in) thick steel plate. Furthermore, a large hole can be cut in the middle of the template to make it easier to pour and spread the concrete into the crib built to create the concrete pad. If the hole pattern is not precisely symmetrical left to right and front to back, "Top" and "Front" should be marked on the top of the template so it is not reversed or inverted when used to line up the rods.

If the concrete is already in place, holes must be drilled for the threaded rods. The base plate, or a template made from it, can be used to mark precisely where the rods have to be installed. Precision drilling is required if the base plate is to slip easily over the inserted rods during installation. Even if 19 mm (¾ in) holes for 12.7 mm (½ in rod) are being drilled, sloppiness may still result in poor alignment of the rods and necessitate that some of the rods be cut off and new holes drilled nearby. For indoor installation, it is wise to have a vacuum cleaner running with its nozzle as close as possible to the hole being drilled in order to capture concrete and stone dust from the drilling as fast as the dust is produced.

Threaded rod can be attached to an already poured concrete pad in various ways. One option is to use a patented type of expanding metal sleeve commonly called a "Hilti" fastener. The threaded metal rod is screwed partway into the sleeve before lowering the sleeve into the hole. "Jam nuts" or lock nuts–two nuts threaded back to back on the rod above the sleeve–are used to drive the threaded rod to the bottom of the sleeve. When the sleeve hits the bottom of the hole, the threaded rod is screwed into it as far as it will go. The rod is then struck hard to set the sleeve permanently. The top jam nut is removed, leaving the bottom nut in place to support the base plate.

Alternatively, a chemical bolt can be installed in the hole. "Chemical bolt" is the generic term for patented fasteners that use adhesive to hold metal to concrete. One typical version uses a separate tool to mix and inject the epoxy components into the hole in the concrete pad. After curing of the adhesive, the metal rod will become permanently bonded to the concrete. The difference in volume between the hole and the rod is extremely important to get right in order to ensure sufficient adhesive for adhesion of the rod to the pad. Using slightly too much adhesive is ideal, ensuring maximum withdrawal resistance while minimizing the difficult mess of too much epoxy to clean up. Threaded rod can be cast into place in the concrete pad using ordinary epoxy adhesives, but the patented version is less messy to use.

The Base Plate

The second component of the mounting system is the base plate which connects the steel mount or mast holding the pole to the concrete pad though the metal rods embedded in the concrete. The base plate (**Figure 2, C**) is a 12.7 mm (½ in) steel plate roughly the same size as, or slightly smaller than, the concrete pad. A 19 mm (¾ in) hole should be drilled for each 12.7 mm (½ in) rod. The base plate rests on nuts and washers screwed onto the rods, and is held in place by washers and hexagonal nuts screwed down onto the rods above the plate (**Figure 3**). The base plate transfers the load of the pole to the pad through the threaded metal rods. Since this force radiates downwards at a 45 degree angle from vertical, the rods must be inset from the edges of the pad and the steel base plate. If the base plate will be 100 mm (4 in) above the concrete pad, for example, the threaded rod should be installed at least 100 mm from the edge of the pad. Because steel is less brittle than concrete, the holes can be nearer the edge of the base plate and still leave the plate adequately strong. So the base plate dimensions could be 100 mm smaller than the concrete pad and its holes drilled 50 mm (2 in) from the edges. For convenience, the holes for rods are drilled in the base plate before the mast is welded to it.

The base plate can be visible (**Figure 4**) or hidden (**Figure 5**). It is easiest and least expensive to simply leave the

Figure 1. The Hunt Family Pole in Montreal, 2006. Although apparently in excellent condition (top), only 3 to 5 cm of good perimeter wood remained around a rotten core and central void (bottom).

base visible. A visible base plate might also be easier to maintain and clean. For an outdoor installation, the base plate should be placed high enough–about 150 to 200 mm (6-8 in)–to keep it out of water and/or snow. It should be primed and painted to resist rusting. A well-maintained totem pole can last at least 40-60 years outdoors. The original 1893 Wakas pole from Alert Bay that is currently at the CMC in Gatineau, Quebec, for example, was outdoors on the Northwest Coast until 1986. Similarly, the Raven pole stood outdoors at Jasper from WWI to 2009 until it was repatriated to Haida Gwai. The Mungo Martin pole at Rideau Hall (**Figure 4**) in Ottawa has been outdoors since 1951. The base plate and mount should last at least as long.

If the base plate needs to be hidden for aesthetic reasons, there are at least two options. For an indoor installation, the least expensive option is to leave the base plate above the floor and then cover it. It can be hidden beneath painted plywood–the solution chosen for poles installed against the exterior wall in the

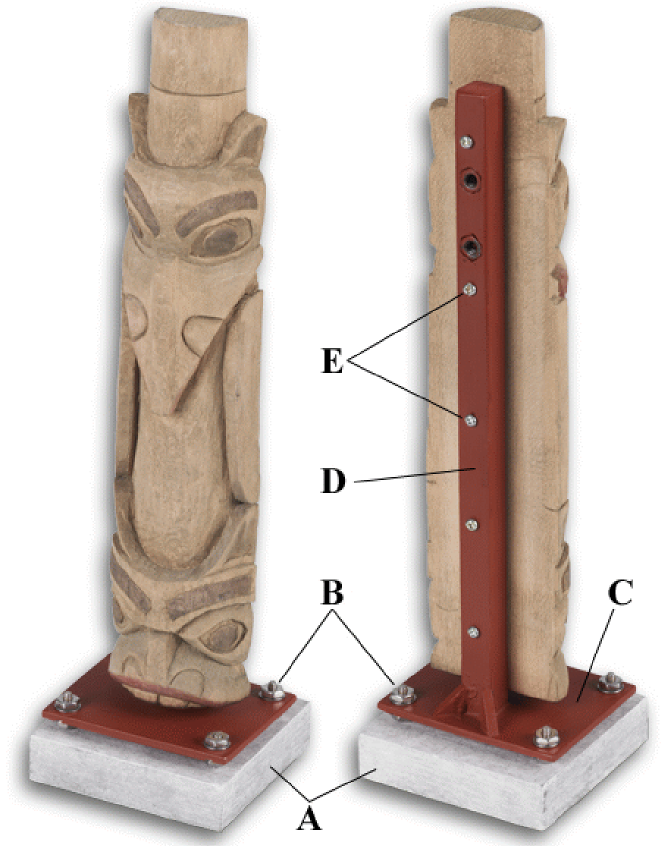

Figure 2. A model illustrating the simplest form of a steel mount which consists of a concrete plinth (A) that supports, on threaded rods secured with bolts (B), a base plate (C) to which is welded a mast (D) attached to the pole with lag screws (E). Photo: Mylène Choquette, CCI.

Grand Hall at the CMC in Gatineau (**Figure 6**)–or covered with gravel to produce a look imitating a traditional installation (**Figure 4**). Given the opportunity, display artists will imagine an infinite range of design solutions to disguise the base plate.

The other main option for hiding the base plate is to sink it into the floor so that the finish floor material extends right over the base plate to the very edge of the pole. This was the solution used for the poles in the village of the Grand Hall at the CMC (**Figures 5 and 6**). This option is not usually recommended for

Figure 3. Detail of a model mount showing the base plate secured to the concrete pad with threaded steel rods and nuts. Photo: Mylène Choquette, CCI.

outdoor installation, where water drainage would need careful management to keep it away from the base of the pole, as well as from the base plate, which would rust rapidly in contact with wet soil. Although the base plate could be made of stainless steel to inhibit corrosion, that choice would be quite expensive and it would still make sense to design the mount so that the wooden pole itself is held above any accumulation of water, snow or ice, to deter decay of the wood material.

The Steel Mast

The steel mast is the third part of the mounting system, the part that attaches onto the back side of the pole (**Figure 2, D**). The custom fit mount usually consists of two parts: one or more vertical posts and a number of cross members or “T’s” through which the mount is attached to the totem pole by means of lagscrews. The design of both posts and cross members depends on the height and shape of the pole, and on exhibit requirements. The steel mast material may be of an “H” or “I” shaped extrusion, which is stiffer in relation to weight per lineal foot, although a hollow square section (“HSS”) extrusion may be preferred, as it was at the CMC, because it looks less industrial and more appropriate for the museum context. For large poles (more than 4-5 m or 13-16 ft tall), an engineer ought to specify the size of the steel column that is appropriate for the mass of the pole and the installation location. If the location is in an earthquake zone, as for example at the CMC, a larger steel support (in the sense of wider post with a thicker wall) may be required. An engineer experienced with the requirements for areas of seismic disturbance is needed in such cases.

The number of steel posts required in the mount depends on the shape of the sculpture. The simplest steel mast is a single steel post with no cross members or “T’s” (see **Figures 4** and **6** for example). Poles that have been pierced by a house entrance hole or doorway, or poles that represent a human standing on two legs, for example, will have to have two masts at ground level so that the steel will not show from the front. At the CMC, a monumental Sisiutl carving stood on three columns, with a horizontal steel support in several pieces to support the 12 m (40 ft) long horizontal two-headed wooden snake. Once the mast has been designed and cut to length, it is placed horizontally and welded to the base plate, which has been placed vertically on edge.

Figure 4. Mungo Martin pole on the grounds of Rideau Hall, the Governor General's residence in Ottawa, showing the front (left) and the mast at the rear (right). The baseplate is exposed, partly visible above the snow. Photos: Mylène Choquette, CCI.

Cross members provide additional attachment points and further stabilize a multi-mast mount (see **Figures 5** and **7**). Working with the mount and pole lying horizontally near each other, the conservator and the fabricator together choose the mounting points for cross members based on measurements of the sculpture, making sure to avoid rotten areas. Drilling holes for lag screws through these steel parts is more convenient before they are welded to the mast or masts, but can be done after, using a drill press with an electromagnetic base. The attachment points and locations for brackets that reinforce the corner space between mast and base plate can also be chosen at this stage and the parts welded in place. The steel work is completed, capped at the top end and painted, before the wooden pole is finally attached to the steel mount.

Attaching the Steel Mount to the Totem Pole

Hexagonal head lag screws are used to attach the totem pole to the completed mount (**Figure 2, E**). Hexagonal head lag screws are not visible from the front and do not disfigure the carved surface, unlike bolts and nuts. The lag screws enter through the steel at the back and are chosen to be short enough not to pierce through the carved surface. One must create a large size caliper of plywood or fluted plastic sheet (e.g. Coroplast) and use it to determine the wood thickness at each point chosen for a screw. Otherwise, one risks having screws run right through the carved face. A pilot hole is first drilled the full depth of the screw at 60% of the minor diameter of the threaded portion of the screw. This is followed by a relief hole as deep as the unthreaded length of the screw, but the full diameter of that portion. This method

Figure 5. The Beaver housepost at the Canadian Museum of Civilization, Gatineau, Quebec, showing the front and back. Exhibit decoration hides the baseplate and the relatively thin walls are attached to cross bars of the mount at many points with smaller screws. Photos: Mylène Choquette, CCI (with permission from CMC).

Figure 6. Rear of the White Squirrel support post at the Canadian Museum of Civilization, Gatineau, Quebec. The metal post is mortised fully into the cedar support post, and the base plate is hidden by the stone floor. Posts against the windows show plywood coverings over the base plate. Photo: Mylène Choquette, CCI (with permission from CMC).

works well for poles carved from entire round logs as well as for poles that have had the rear face cut away and hollowed to remove the heartwood.

The number of attachment points required depends on the weight of the pole, and their location depends on the local condition of the pole (**Figure 7a** and **b**). It does not take many lag screws to support a totem pole, even a pole that weighs about 1800 kg (4000 lbs), as long as the wood is sound and thick enough to accept 12.7 mm diameter by 300 mm long (½ in x 12 in) screws. A base estimate for the number of lag screws required can be calculated using the published information on withdrawal resistance for the inches of threaded screw from specific wood species. Using Brungraber's data,[4] one 300 mm (12 in) lag screw in Western Red Cedar provides 572 kg (1262 lbs) of withdrawal resistance. Thus, four such screws would provide a withdrawal resistance of 2289 kg (5046 lbs), as much as the heaviest pole at the CMC. In practice, three or four times as many screws as required may be used to ensure that the artwork remains securely attached to the mount. Detailed specifications for fastening wooden timbers using lag screws can be found in the *Wood Design Manual*.[5]

Not all sculptures will be thick enough to be attached with lag screws. Although house frontal poles are generally thick enough to accept 300 mm (12 in), 250 mm (10 in), or 200 mm (8 in) long screws, carved interior house posts will likely not. Such poles are usually facades placed in front of the actual structural house post and may thus be only 75 mm to 100 mm (3 to 4 in) thick in places. For these thinner poles, it would be necessary to use 50 mm (2 in) wood screws instead of lag screws, and the number of attachment points required for sturdy reliability would be much higher. In general, the screws should be an inch shorter than the measured thickness of the wood, maximizing holding power while minimizing risk to the all-important carved surface.

The location of the attachment points is important. The entire reverse face of the artwork must be examined in order to ensure that the attachment points are capable of bearing weight,

Figure 7a. Rear view of the "Fox Warren Pole" at the CMC. This pole was sawn in two in the early 1880's, so that it could be fitted onto the deck of a sailing ship to be taken around the Horn from B.C. to England. Near the bottom of the image there are two horizontal metal straps close to each other on both sides of the kerf separating the upper and lower halves of the pole. These straps were put there to maintain alignment of the top and bottom parts of the pole during the lift to vertical, as well as for permanent display. Photo: Mylène Choquette, CCI (with permission from CMC).

are structurally solid, well-connected to sound surrounding material, and are capable of receiving lag screws. On ancient poles, there will likely be rotten areas. A simple probe with an awl or the use of an IML Resistograph may identify such areas. The mount can normally be designed and made only after any conservation work and/or restoration is complete on the rear. Locations where the wood is thickest and strongest should be chosen for fasteners, avoiding regions on the pole that are narrowed or thinned, such as neck areas beneath an adjacent carved head. Where human figures are carved into a pole, for example, screws are often inserted into foreheads or shoulders. Installing a screw may cause cracking if the wood at the location is rotten, too thin, too dense (knots), or too near an end. The pole should be supported horizontally with sawhorses or similar structures above or next to the mount to make accurate measurements of attachment locations.

Wooden shims may be needed to fill gaps that remain between the artwork and mount, particularly if the pole is highly decayed. Gaps may result in excessive point loading wherein a single fastener with an excessively high withdrawal force could tear a section right out of the pole at the beginning of the lift. Gaps may also create twisting forces sufficient to twist and break the pole in two during the lift. Gaps are difficult to avoid even with the most careful measuring and custom fabrication. Western Red Cedar shims, cut with a gentle slope[6] and pre-drilled, are installed wherever there is a gap of over 2 mm (**Figure 7b**). Lagscrews are driven in through the shims until the bottom side of the hexagonal head contacts the mount, then backed out one quarter turn. Such installation ensures that all lagscrews bear an equal load, thus minimizing if not eliminating excessive point loading and unnecessary twisting forces on the pole. As they are much stronger, new poles generally do not require shims.

A pole that will be displayed indoors can be placed with its base touching the base plate because immersion of the base in standing water will not be an issue. For a pole designed for outdoor display, on the other hand, the base of the pole should be 150 to 200 mm (6-8 in) above the base plate. This distance will ensure that the base of the pole remains out of water, snow and wet debris. This will delay rot at the bottom of the pole for as long as possible.

Erecting the Mounted Pole

Once the pole is screwed to its mount, all pulling, pushing or lifting movements are accomplished with a lifting harness attached to the steel mount. The pole scarcely needs to be touched again to manoeuvre and elevate it. Thus damage caused by handling is minimized. That said, there are many ways to erect a pole indoors, and the smaller the pole, the easier. From lowering poles into stairwells through holes cut in the roof, to carrying them through walls and then transporting them over indoor obstacles such as fountains, there is a huge range of possible problems and solutions. What follows is meant to be a basic guide to the simplest installation for a pole perhaps 7 m or 20 ft tall. The focus is on the technical aspects of an installation only and does not discuss cultural aspects such as the need for a ceremony or blessing when erecting a pole.

Figure 7b. Closeup of the horizontal metal straps with shims visible between the pole and the straps. Photo: Mylène Choquette, CCI (with permission from CMC).

The installation of the pole requires riggers: people who will call themselves “crane operators” or “operating engineers” who are usually contracted by the museum for this task. Moving totem poles may seem to be a relatively simple job for skilled operators with lots of experience moving immense, highly valuable objects that may weigh as much as 250 tons, such as jet engine test equipment or hydroelectric generators. It is critical to find riggers who understand the value of totem poles and who are eager and proud to do any work with poles, because they are in charge once the pole is in the air. Extensive discussion beforehand will ensure that everyone knows precisely what to expect during the installation.

The lifting harness comprises several pieces. The lifting frame is a metal cross bar shaped like the horizontal part of a capital “T” (**Figure 8, a**). The lifting frame is attached to the mount or mast by a bolt or drift pin. If a bolt connection is used, a hole is burned or drilled[7] into the rear of the mast and a 12.7 mm (½ in) hexagonal nut is welded flush with the outside of the mast. The lifting frame simply bolts into that nut. Alternatively, holes are burned or drilled right through the left and right sides of a HSS tube mast and drilled through two flanges attached to the lifting frame so that the flanges straddle the mast at that point with holes aligned. A 19 mm (¾ in) steel drift pin, hexagonal bolt or rod can be passed through all holes across the entire thickness of the mast. The pin is secured with a nut or cotter pin so that it will not fall out while in use. Two chains or cables (**Figure 8, b**) connect the lifting frame to a spreader bar (**Figure 8, c**) by shackles at the ends of the lifting frame. The lifting frame must extend past both sides of the pole so that connecting chains rise clear of the sculpture. The chains meanwhile must be long enough so that when the pole is vertical, the spreader bar is well above the top of the pole. A lifting wire (**Figure 8, d**), from a lifting apparatus such as a crane, attaches to the spreader bar through a U-bolt or hole in a plate welded to the top of the spreader, so that the lifting wire never touches the sculpture. If a hook is used through the centre hole in the spreader bar, it must have a safety lock to prevent detachment during the lift. No choke hold of wire rope or nylon strap around the pole is required to lift it securely, so delicate carving will not be damaged. This apparatus also satisfies the civil engineer who must sign off that all the connections are safe and reliable.

The mount design must provide for sufficient headroom between the top of the mast to the lowest point in the ceiling for the lifting apparatus. In most situations it is most convenient if the steel mast is between 60 to 90% of the full height of the pole. The mast does not need to be as tall as the pole, as long as its height is above the centre of gravity of the pole/mount assembly. A crane will require roughly 1 to 1.2 m (3-4 ft) vertically to accommodate the swivel hook beneath the "headache ball" or round steel weight fixed at the end of the lifting cable, and the cable pulley wheel above that at the top of the crane boom. Even if the pole is raised by a cable puller or a chain fall hoist, there has to be some headroom between the top of the mast and the ceiling. That said, the pole can be just 15 cm (6 in) shorter than the ceiling if the ceiling can be opened to accommodate the upper lifting harness and cable or if the top of the pole is a separate section installed after the rest of the pole is erected.

Using a propane fuelled or electric crane to lift the pole indoors or through a hole cut in the roof is most convenient. The crane simply has to be driven delicately into position. Otherwise, scaffolding towers will have to be erected on both sides of where the pole will be erected, and a beam carried to the top of the scaffolding towers and lashed to them in the correct position. The pole is manoeuvred horizontally so that its top is resting where it will finally stand, and the lift cable is paid out until it can be fastened to the pole. When the lift begins, the pole and mount will bend very obviously, almost alarmingly, especially with a

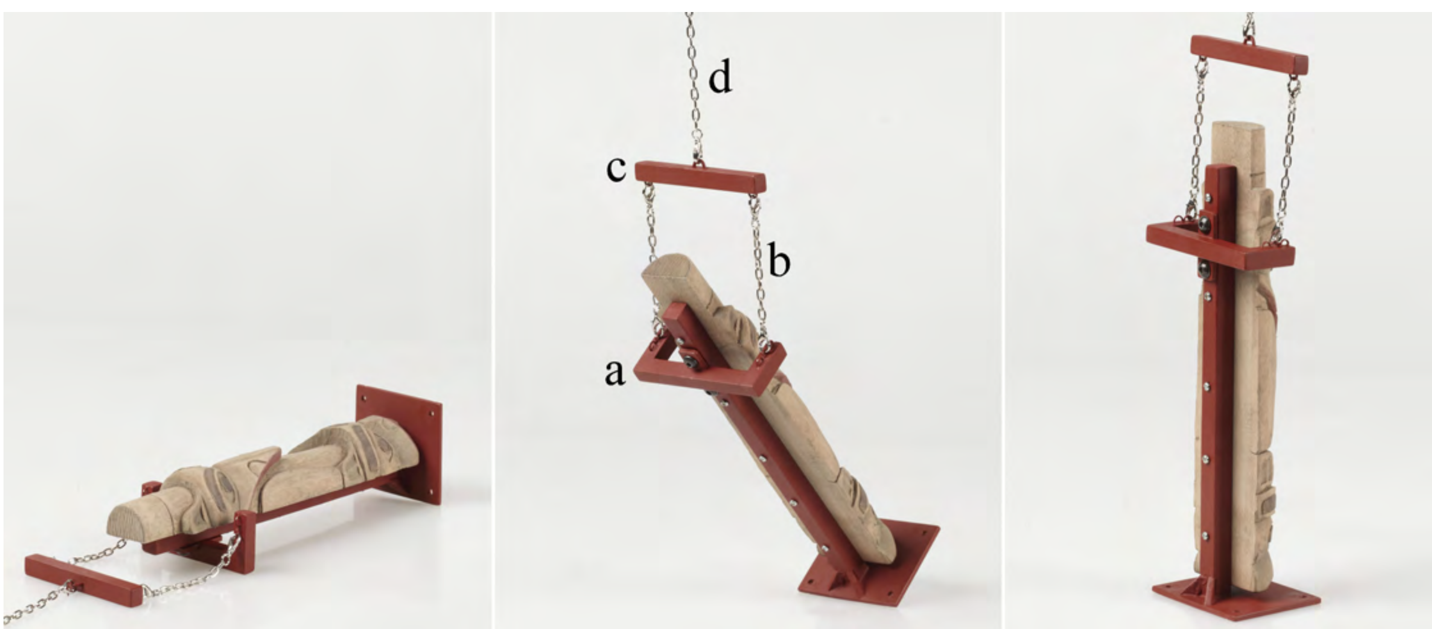

Figure 8. Model of mounted pole being lifted with lifting harness showing the lifting frame (a) temporarily bolted to the steel mount, attached by chains (b) to the spreader bar (c) and then by a lifting wire (d) to the crane. Photo: Mylène Choquette, CCI.

pole weighing 1800 to 2300 kg (4000 to 5000 lb). The steel mount carries any tensile forces while the pole bends and is put into compression. The harness system allows the forces to be increased slowly at first, preventing sudden overloading that could otherwise damage an old, decayed pole. A new pole, of course, is more than strong enough to survive being slung and lifted without a steel mast. The beauty of this method is that it ensures that a pole is not at risk of having its carving damaged while being erected.

To protect floors and facilitate the lift, the base plate needs some type of support. Only half the weight of the pole/mount is on the hook attached to the lifting harness; the other is on the edge of the metal base plate, sliding across the floor. Resting the base plate on pieces of scrap industrial carpet or on a very sturdy dolly may be sufficient for smaller poles. At the CMC, the crane operators designed and built a special wheeled piece of 150 mm (6 in) angle iron for a "tailing in" dolly–very convenient for immense poles. The lift continues until the pole is suspended in air above its pad.

At this point the pole must be lowered down very slowly so that the holes in the base plate can be lined up with the threaded rods sticking out of the pad. All the nuts and washers should be on the rods in the pad already. For a big pole, orienting the base plate and pole may take two or three people as well as a supervisor giving directions via hand signals to the crane operator. A "fid" (also known as a drift)–what the riggers use in order to obtain that crucial last few millimetres of orientation–or other spike-like tool can be very helpful. If one of the rods in the pad is 25 mm (1 in) taller than the rest, the team can more easily focus on anchoring the floating 1800 kg (about 4000 lbs) sculpture on just that one rod, and then rotate it around until all the other holes line up above their rods. When the pole is in place, it is lowered so that all rods in the pad protrude through holes in the base plate. Then, washers and nuts are fitted onto all the rods above the plate. Nuts are left loose and well above the pad while the pole position is adjusted.

The decision about whether or not the pole is "vertical" is based on aesthetic considerations. Totem poles are carved from green trees, and trees tend to grow with a little twist and bend. As they dry, they tend to twist and bend even more. The pole only has to "look" vertical, as there isn't a straight line anywhere to measure. Leveling the base plate is of no use. The vertical orientation of the pole is adjusted by raising or lowering the hexagonal nuts beneath the base plate until a satisfactory visual effect is achieved. The nuts at the top of the rods are then lowered and wrenched tightly against the base plate. The pole is now safely tethered to the ground.

Once everyone is completely satisfied with how the sculpture is sitting, the lifting harness must be disconnected from the steel mast. This may be accomplished from a ladder for a small pole, while a huge pole might require a man lift or scaffolding. The cable should be slackened off enough to allow the bolts or drift pin to be removed. The harness is then lowered to the ground where it can be detached from the crane and removed. At this point the crane boom can be brought down, and driven away, or the scaffolding can be dismantled to be removed.

Conclusion

Steel mounts have many advantages, particularly for old, heavily degraded poles. One can fully support a pole from behind and compensate for almost any degree of deterioration. The mount can be designed to be invisible from the front. The mount makes it easy to adjust the vertical position of a pole. Most importantly, these types of mounts are strong and safe both for the artwork and the viewing public. The system has advantages for use with new poles as well. When the cost of a suitable tree was limited to the labour required to find, harvest and transport it to where it would be carved, using a fifth of the tree for the mounting method was the natural choice. For contemporary carvers, a steel mount might be an acceptable variation of the traditional mounting method, making it possible to use the entire log for artistic expression, with none of it buried out of sight. The method is durable, versatile, secure, and when necessary in a generation or two, repairable.

Acknowledgements

Thanks to my former colleagues (now retired): Dr. George MacDonald, President and CEO of the CMC, for providing the incentive to conserve the totem poles for exhibition in the Grand Hall of the museum; and to Tom Govier, Head of Conservation; and Charles Hett, Chief Conservator at the CMC, for managing to make the pole project possible. Thanks to Michel Saumure of Public Works and Government Services Canada for engineering the original mounting method. Thanks to Michel (Mike) Scott for highly expert steel welding and fabrication to custom make the mounts. Thanks to Bob and Morris Dulepka of Dulepka Equipment for improvising to find the solutions required to erect the poles indoors, in tight confines, yet totally without damage to the art or the building, or injuries to the crew. Thanks to all my colleagues at the CMC, particularly those in the conservation section, for their expertise, perseverance, and cheerful collaboration in this immense project.

Materials

Hilti fasteners, chemical bolt: Hilti Canada Corporation, 2360 Meadowpine Blvd, Mississauga, Ontario L5N 6S2.
Tel: 1-800-363-4458; fax: 1-800-363-4459; www.hilti.ca.

IML Resistograph: IML Inc., 1275 Shiloh Road, Suite 2780, Kennesaw, GA, 30144, USA.
Tel: (678) 819-2030; fax: 678-819-3661; www.imlusa.com.

Lag screws: Available at most hardware stores such as Home Depot and Home Hardware, or from specialist suppliers such as Ottawa Fastener Supply and Acklands-Grainger.

Notes and References

1. Few descriptions of mounting techniques are available in the

conservation literature. One example can be found on pages 211-213 in: Rhyne, Charles, "The Challenge of International Standards: Nineteenth Century Native American Totem Poles as a Case Study," in: ***Kulturgut erhalten: Standards in der Restaurierungswissenschaft und Denkmalpfleg***, Berlin, 23-25 April 2009, edited by Uwe Peltz and Olivia Zorn (Mainz: von Zabern, 2009), pp. 209-217.

2. "Slump" is the distance a cone of liquid concrete settles when it is released from a "slump test cone", and as such is a measure of the consistency, workability, and quality of the concrete mix. See ASTM C 143-10, "Standard Test Method for Slump of Hydraulic-Cement Concrete" (West Conshohocken, PA: ASTM International, 2010), <http://www.astm.org/>. Accessed March 2011.

3. *National Building Code of Canada 2005* (Ottawa, ON: National Research Council of Canada, 2005), <http://www.nrc-cnrc.gc.ca/index.html>. Accessed March 2011.

4. Brungraber, Robert L., *Timber Design Manual* (Belmont, CA: Professional Publications, 1983), <http://ppi2pass.com/ppi/PPI>. Accessed March 2011.

5. *Wood Design Manual* (Ottawa, ON: Canadian Wood Council, 2005), <http://www.cwc.ca/>. Accessed March 2011.

6. Wedges with a ratio of rise to run of 1:30 (e.g. 1 cm rise for a shim 30 cm long) would be appropriate.

7. Holes for bolt connections are usually burned rather than drilled through steel since a man can burn a hole through steel with a cutting torch in about 2 seconds, 300 times faster than drilling. Burning is not appropriate if the pole cannot be positioned far enough away to avoid the risk of fire or if a clean hole of precise diameter is required, as for the lagscrews.