The Care and Preservation of

Historic Log Buildings

By Lauren Sickels-Taves, Architectural Conservator, The Henry Ford (1997-2000)

Historic log buildings can be maintained for years of use and enjoyment provided that some basic attention is given to their care and preservation. The conservation staff at the Henry Ford Museum and Greenfield Village have compiled the information in this fact sheet to assist in helping individuals to care for their log buildings. The first step in the care of buildings is to understand and minimize or eliminate factors that cause damage. The second step is to develop and follow a basic maintenance plan for care and longevity.

IDENTIFYING LOG BUILDINGS

Log structures have long been stereotyped. The American imagination envisions a one-room, termed single pen, building constructed of hewn logs exactly like toy Lincoln logs, and the majority of them probably believe the log structure to be representative of the homes our ancestors first built upon arrival in America. Within the last two decades, scholarly research has been compiled, debunking these images and expounding on the diversity of construction methods found to vary by geography and nationality. Log structures were not confined to a single pen and some required seventy-six tools to construct.

Log buildings were characteristically constructed with logs and chinking. Only the most basic of buildings employed round logs. This type generally suggested impermanence and its simplicity led to the term 'log cabin.' The more popular hewn-log structures are called 'log houses,' and tend to be larger. The work involved in construction, particularly the hewing, suggests permanency. Log houses of the eighteenth and nineteenth centuries, east of the Mississippi, were covered with a whitewash or clapboards to protect the structure and denote status.

IDENTIFYING FEATURES

HOUSE PLANS

Historic log buildings are largely identifiable by four basic plans: single pen, double pen, saddlebag, and dogtrot. The latter three plans are easily denoted as extensions to a single pen or one room.

- A double pen is merely two single pens, each with its own end chimney.

- A saddlebag is similar to a double pen, but the one chimney is centrally positioned and serves both pens.
- A dogtrot is a double pen with each pen separated, yet connected by a covered breezeway.

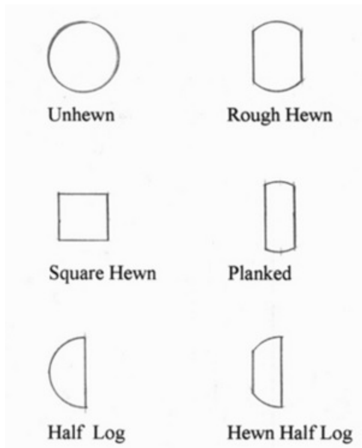
LOG SELECTION

The geography of the land dictated the materials employed - with the exception of glass, hardware, etc. Indigenous trees provided long, straight, and rot-resistant logs. Oak, pine, and cedar were popular in the South; oak, ash, popular, and locust were found in the East and Midwest. Chestnut had the best of all qualities.

LOG PREPARATION

There were basically six ways to prepare logs in American domestic architecture: unhewn, rough hewn, sqaure hewn, planked, half log and hewn half log. (These methods are not be confused with boards cut from logs, as the finished product is no longer a log.)

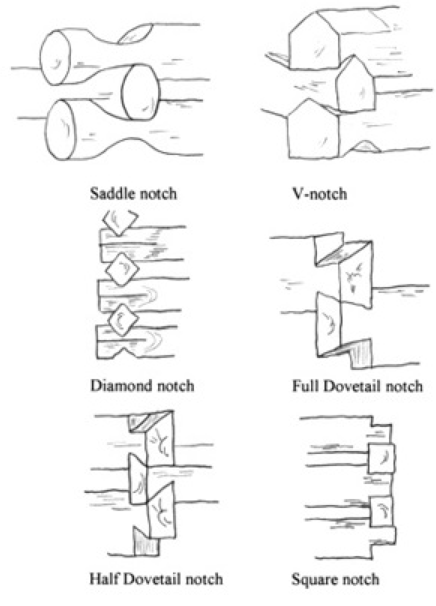
- Unhewn logs are merely felled tree trunks. They are not cut with any tool, but occasionally are debarked.
- Rough hewn logs have two sides debarked and slightly cut to provide a rough but flat surface.
- Square hewn logs are formed by hewing all four sides of a log.
- Planked logs are hewn on two sides only, with bark remaining on the top and bottom. The flat sides served as the inner and outer walls.
- Half logs are created by merely cutting a log in half.
- Hewn half logs have the rounded side debarked and slightly cut to provide a rough but flat surface.



LOG PREPARATION

NOTCHING

A notch is defined as a concave or V-shaped cut or indentation in an edge or across a surface. There were six basic methods of producing a true corner-timbered joint: saddle notching, V-notching, diamond notching, full dovetailing, half dovetailing, and square notching. Corner notching on log structures can be used to specify nationalities within a geographic perimeter.



NOTCHING

- Saddle notching is achieved by cutting a U-shaped groove in the top and/or bottom of a log such that they fit together like Lincoln logs. This notch takes minimal skill and logs are usually unhewn.
- V-notching is created by cutting an inverted V whose ridge is parallel to the length of the log at the top end. A similar but perpendicular inverted V is notched into the underside.
- Diamond notching, the least popular notch, is created by clipping the 'corners' off the log, leaving a diamond-shaped end.
- Full dovetail, the tightest and most time-consuming notch, resembles the dovetail joints in furniture. The log's end is a splayed tenon.
- Half dovetail is similar to the full dovetail except that only the top portion is splayed.
- Square notching is created by merely removing a 90° chunk from the top and bottom of the log, thus forming a tenon.

With the exception of square notching, each log is fitted into the ones above and below it, eliminating the need for nails or pegs. Each of these notches can be broken down into subgroups. For example, logs employed in creating the saddle notch can be grooved on the top of the log, just the bottom, or both top and bottom. Distinct terminology exists to precisely label the features of corner-timbered joints.
Saddle notching, V-notching, and full dovetailing were the more popular notches. The philosophy behind these notches was that no water collected in the joints, thus preventing rot. V-notching was more prevalent than the full dovetail on house construction. Saddle notching was generally used on outbuildings where the logs remained unhewn, but only the bottom notch was employed.

CHINKING/DAUBING

When properly prepared and notched, logs were stacked such that they did not rest against each other except at the notch. A crack or chink of one inch or more was visible between the logs of a wall. Chinks allowed for warping and expanding when unseasoned wood was used. They also permitted builders to work with the irregular surfaces and natural tapers of logs. As with notching, chinking was influenced by different cultures. Chinking was a two-part process whereby two fillers were used to close gaps (or chinks) between the logs. Daubing was the outer finish layer. If maintained, they effectively sealed the interior from exposure from the elements, intrusion from vermin, and pooled water on the tops of logs.

The materials used for the rigid filler varied, and were merely a product of local materials. Clay, stones, poles, wood chunks, and split wood shingles have all been used. The soft filler served to fill small cracks and crevices around the rigid fillers and provided a surface for the daubing to adhere. Oakum, moss, clay, straw, paper, cloth, and even dried animal dung were typical soft fillers.

Daubing was the final seal of the three-part process. Mortar was perhaps the most popular daubing. It was comprised of solely clay, mud, or dung; or consisted of a mix of lime and water. Binders included sand, hair, straw, ashes, flour, sawdust, and shredded newspaper. Bark remaining on the logs served as an excellent binding agent. Modern materials have included cement, and even chicken wire or metal lath are a daubing key, though all are unacceptable materials, being non-historic and incompatible.

NOTE: Although 'chinking' and 'daubing' clearly define the difference stages of the three-part process, the two words are often, albeit incorrectly, used interchangeably. Popularly, 'chinking' is used alone to describe all steps.

EXTERIOR ALTERNATIVES

Exterior or exposed log walls were known to have been covered, for both practical and aesthetic reasons, and depending on available funds. (Builders in poor, rural regions rarely covered log buildings.) Whitewash, clapboards, and stucco were all used. As chinking and daubing were known to develop hairline cracks due to seasonal movement, annual inspection and renewal were expected. Whitewash was one solution; its partial solubility with water (e.g. rain water) allowed it to seep into seasonal cracks then re-solidify with dry weather.

Clapboards and stucco, however, were more durable forms of protection. They served as additional forms of insulation and reduced the annual need for maintenance. It was not uncommon for these materials to be added well after the construction of a log building to denote positive changes in financial or social status.

Occasionally, chinking was eliminated altogether and other alternatives employed. For heat retention in plank-shaped wall logs, longitudinal grooves were cut the length of each log along its bottom. The top of the log below was stacked with sphagnum moss or even textiles, allowing the grooved log above to fit tight. Chinking was not needed.

Sheathing the interior walls has been used as well.

OTHER

Other features of log structures include foundations, roofs, chimneys, and perhaps windows and interior finishes. As the materials used varied based on location and nationality, it is difficult to address their care and preservation. Attempts should be made to ascertain the original material and replicate it as close as possible. A professional can aid in examining the structure for clues.

- Foundations: Depending on the structure's permanency, typical foundations included flat stones laid dry or with mortar; piers of stone, brick, or log; or logs known as sleepers laid directly on the ground.
- Roofs: One of the most common materials used was wood shingles. By the mid- to late 19th century, standing seam metal roofs were a typical replacement. Sod has also been used in regional areas.
- Chimneys: Available materials dictated chimney construction. Brick was the typical material used, although later chimneys were made with metal stacks if wood stoves were employed within.
- Windows: Windows varied according to social status and availability. Log structures ranged from no windows to mere holes covered by wax paper or a shutter to glass.
- Interior finishes: Interiors were generally covered for the same reasons exteriors were chinked: to increase insulation and to keep pests out. Wall surfaces, therefore, were practical, consisting of whatever was on hand. The interiors of rural log structures were merely chinked or left untouched. Other structures had boards covered with newspaper or fabric; decoration, until the mid- to late 19th century, was not common practice.

CAUSES OF DETERIORATION

Water, incompatible materials, and lack of maintenance are the major causes of damage to log buildings. The introduction of water is usually the result of the incorrect use of materials and the lack of maintenance; 95% of all deterioration can be linked to water. Once introduced and allowed to remain, water can propagate rot, encourage insect infestation, and fungal growth. Allowed to continue, a building will eventually become unstable and collapse.

ENVIRONMENT

Bark forms a protective barrier around the wood of a tree. This does not prevent deterioration of the wood under adverse conditions; however, it greatly reduces it. Logs that have been debarked have an obvious increased exposure and therefore are at greater risk for infestation by pests and fungi, and rot by water.

WATER

The moisture content of building materials varies in response to changes in the local humidity and will not usually damage the material or induce decay. It is normal to find logs containing 12-16% of water by weight. Timber is not susceptible to fungal attack until its moisture content exceeds 21%. (A moisture meter can easily record this percentage.) This increase is generally caused by some form of water, manifested as leaks, excessive condensation, or contact with damp, incompatible, less porous materials.

Water can enter and harm structures in a variety of ways. The path it takes in buildings from entrance to exit can be illogical. There are three sources of water: rain penetration, rising damp, and condensation.

- Rain penetration in historic log structures is generally caused by the effects of structural movement, the wrong choice of materials for repair, decaying materials, badly executed repairs, or lack of routine maintenance. It is the single, greatest source of log deterioration.
- Rising damp occurs when logs are in direct contact with damp soil. Moisture is drawn into the pores by a physical process called capillary action. The absorbed moisture will rise in the wall to a height at which there is a balance between the rate of evaporation and the rate at which it can be drawn up by capillary forces. This height will vary somewhat with the time of year and the level of the water table of the soil. With correct spacing between logs, the chinking may serve as a barrier to prohibit extensive rising damp.
- Condensation is the product of cooled water vapor. When moisture in the air is cooled at a certain temperature called dew point, it will change to liquid water.

The grounds immediately around log structures play an important role in minimizing water damage. Poor drainage and shallow eaves can allow water to build up near the lowest logs, permitting rising damp and coving. Excessive water can ultimately cause shrinkage in logs, in particular turning checks into cracks that in turn can twist, bend, and warp.

PESTS

Insects that can cause damage to wood include wood-boring beetles, termites, carpenter ants, and wood wasps.

There are a number of wood-boring beetles. The three families most commonly affecting wood in buildings are Lyctidae and Bostrychidae (powder post beetles) and Anobidae (furniture beetles). They characteristically bore small holes (approx. 2-3 mm in diameter) into wooden materials. These holes are usually the first visible evidence of infestation. The insects attack dried wood and reduce it to a powdery or pelleted mass called frass. In cross-section, infested wood is filled with tunnels, usually parallel to the grain. Hardwoods, particularly oak, ash, and hickory, are most susceptible.

Termites fall into three categories: subterranean, dampwood, and drywood. As the categories imply, termites prefer three types of environment. The only geographic areas free of these pests are the northern Midwest states and northern New England. Earthen shelter tubes, constructed as bridges across materials they cannot eat, are clues to the presence of subterranean termites. Fecal pellets are evidence of dampwood and drywood termites. Tunnels in the direction of the wood grain are common with these pests as well.

Carpenter ants are considered the greatest pests in the Northeast and Pacific Northwest. Wood is used as housing, not a food source, and their preference is for wood exceeding 15% moisture content. Infestation is evidence by the presence of frass, but the ants are usually visible themselves, and their chewing is sometimes audible. Damage is generally minor and localized.

Wood wasps are not a common pest to wood. Their attraction is to fungi, and weakened living trees. They do bore into wood, leaving 7mm exit holes. Eliminating fungi should control this pest.

Prevention is the only way to keep all these pests at bay. Wood repeatedly exposed to water and ground contact serve as a catalyst. Proper drainage around the log structure and the removal of all unnecessary wood debris or firewood near the building will help. Sill logs should not rest directly on the ground, but be laid on a non-wood foundation. This enhances ventilation underneath as well. Once found, pests can only effectively be removed by a professional.

FUNGI

Fungi destroy the structural integrity of wood. There are many different types, ranging from wood destroyers to rots, and each attack different structural elements within the wood. Conditions suitable for fungal growth are temperatures of 24-32° C (75-90° F); 20% air volume in the wood; and 25% or higher moisture content. Changing these conditions can kill fungi and its spores. Temperatures above 65° C (150° F) and moisture levels below 18-19% (e.g. kiln-dried wood) will kill spores and stop decay.

INCOMPATIBLE MATERIALS

Traditional building materials are more porous than their modern substitutes. They will absorb more water but have the advantage of allowing it to evaporate freely under drier conditions. When certain modern materials with low porosity are introduced during maintenance and repair, incompatibility becomes an issue. There is a decrease in natural ventilation that can cause persistent dampness in many old buildings. The logical progression is rot and deterioration.

PORTLAND CEMENT

Cement and its various forms can do irreparable damage to log structures. It has most popularly been used as the sole ingredient in chinking, which in itself is historically inaccurate. Its density reduces uniform breathability throughout a structure, causing areas such as logs to become saturated with water - in effect taking in more water faster than it can release it.

Chinking should be flexible, and it should never be stronger than the material to which it adheres. By employing cement, a rigid, incompatible chinking is being introduced; the logs bear the full brunt of any seasonal movement and absorb the bulk of all water.

CAULKS AND SEALANTS

Caulks and sealants are soft moisture-impervious compounds; they have little or no ability to breathe. Caulks should be used in locations where movement is minimal. Sealants are designed to be flexible in areas with anticipated movement; their elasticity maintains the integrity of a joint.

However, these modern products are not suitable for historic log structures due to their non-porous nature as well as being historically inappropriate. Caulks and sealants, generally, have improved lately to achieve colour stability, and resist ultraviolet rays and mildew, but their impervious nature prohibits them from working with traditional building materials, particularly wood.

CHEMICALS

Water-based and toxic chemicals are not effective for general treatment of wood, and in fact, can escalate decay as well as visually alter the colour and appearance of the logs. Water-based chemicals require repeated applications and do not prevent water from penetrating logs through cracks or joints. Water repellents can trap water within, promoting internal rot. Toxic chemicals, including pesticides and fungicides, should only be used in specific treatment, such as exterminating dangerous fungi (e.g. Serpula lacrymans), and where no other alternatives remain.

LACK OF MAINTENANCE

While water does the most harm to buildings, it is merely a source of damage. Lack of maintenance is the key catalyst to its introduction. No building can go without maintenance. If regular maintenance is carried out, the longevity of the structure is assured and the financial outlay for major repairs is minimized.

Lack of maintenance can be graphed as a downward curve. Initially, the plateau of status quo begins to sag. As maintenance is deferred, the curve deflects more until it reaches a vertical line, indicating that collapse is imminent and the costs of salvation will be exceedingly high.

REPAIRS

Reversibility is a prime issue in repairing historic buildings. It minimizes problems during maintenance and future repairs, and helps to maintain the integrity of the structure. Replacing decayed components with compatible materials ensures that the new and old materials will work together.

NOTE: Unfortunately, most current sources for chinking, daubing, and wood protection are geared towards modern log construction. One of the key ingredients is acrylic, which is not a historic material. These new products may not physically harm log structures, but their use may create long-term problems and they may not be totally reversible.

WOOD
There are varying degrees of log restoration, ranging from consolidation (stabilize existing) to splicing to entire replacement. Each historic log structure should be evaluated on its own merits to determine the most appropriate repair. Every attempt should be made to save as much historic wood as possible.
Generally chemicals are not recommended for preventing damage to logs (see Chemicals above), and they are difficult if not impossible to apply in situ. Full-depth penetration is rarely achieved. Preservatives can change the colour and appearance, greatly altering the historical integrity and aesthetics. Boiled linseed oil is one preservative that has been used historically where signs of weathering, such as deep checks, are evident. However, epoxies are the one product that is used - in limited quantities, in small areas - by professionals. Epoxies are comprised of a two-part system; a resin paste and a hardener are combined to make a paste. It is applied like putty to fill isolated, damaged areas in logs, and once hardened, can be carved or sanded to replicate the missing wood. Pigments can be added to most epoxies to blend the new colour with the original wood.

NOTE: Since epoxies are adhesives with resistance to water and weather, they should strictly be used in limited quantities. They can force the surrounding surviving wood to retain water. If the wood cannot sufficiently dry out, epoxies can continue rot and the problems it was used to fix.

Shrinkage and swelling result from logs undergoing cyclical moisture loss and gain. This is expected in historic logs, and as long as surrounding materials such as chinking are traditional and compatible, the various components will work together. The introduction of new wood that has been pressure-treated or even saturated with polyethylene glycol (PEG) can create new, unnecessary problems, usually associated with increased moisture in the older, surrounding wood. Repairs are best made with materials that are traditional to the structure.

Despite all attempts to retain as much historic wood as possible, there are occasions where replacement is the only solution. Qualified professionals should be sought to undertake the specialized work of jacking, bracing, and replacing. New logs should be of the same species and appearance, particularly the tool marks and notching, as original logs. Specific methods on repairing and replacing logs in buildings are given in Preservation Brief #26 (see Bibliography).

CHINKING/DAUBING

Traditional materials are recommended when chinking and/or daubing repairs or replacement are necessary, despite the fact that they may require annual attention. The retention of historical integrity and the lack of problems due to compatibility with surrounding logs far outweigh the trouble of undertaking seasonal repairs. Settlement and other forms of movement over the life of the log structure may have closed the gap between logs, prohibiting the insertion of a rigid filler such as stones or wood chunks. Smaller fillers such as thin saplings may be used and held in place with nails, prior to repairing the soft filler.

Oakum and clay are two of the traditional soft fillers still available today and readily used by professionals. Oakum originally was jute soaked in tar or similar material; a modern equivalent is readily available at most stores carrying plumbing supplies. It is preferred for two reasons:

- Most insects do not like oakum;
- Oakum serves as a tight insulating barrier without the potential for cracking like dry clay.

Occasionally, galvanized mesh lath has been used in lieu of a soft filler. The philosophy is that it is a concealed aid that increases the adherence of new daubing. This material is neither historically correct nor has served well in the field. If localized areas of daubing fall out, the mesh is exposed, creating an unsightly appearance until repairs are done.

Chinking should always be misted - not saturated - with water prior to the application of daubing. This will increase the bond of the chinking with the daubing, and will prevent the chinking, particularly if it is clay, from drawing the water out of the daubing and creating hairline cracks in the latter upon drying.

Many daubing recipes have been published over the last decade. A favorite cited in several publications is:

1/4	parts by volume cement	
1	"	lime
4	"	sand
1/8	"	dry colour
		hog bristles or excelsior

With the exception of the cement, this mix has ingredients traditionally found in daubing recipes. The minor inclusion of cement will impart additional strength and aid in reducing the amount of annual maintenance needed. Do not attempt to increase the amount of cement due to its lack of porosity and other reasons cited under Incompatible Materials above.

Man-made additives should never be used. The properties, such as freeze resistance, they impart to the recipe are generally unnecessary and have largely been tested on modern construction only. Daubing should be completed before cold weather and freezing temperatures, above 10° C (50° F) is best.

MAINTENANCE PLANS

Historic log structures require annual inspections. Traditional chinking and daubing may need annual renewal or spot repairs. Keeping logs dry and off the ground as well as directing water away from log structures are critical. Without this care, the above environmental causes of deterioration will inevitably occur.

By establishing a regular maintenance plan, areas comprised of missing materials or problems that can ultimately cause decay can be addressed early. Repair costs will be dramatically reduced while the longevity of the historic log structure will be assured.

BIBLIOGRAPHY

- "Conservation of Log Structures." APT '96 Training Workshop. Manitoba, Canada: Riding Mountain National Park, 1996.
- Attebery, Jennifer Eastman. Building with Logs: Western Log Construction in Context. Moscow: University of Idaho Press, 1998.
- Banov, Abel. Paints and Coatings Handbook. Farmington, MI: Structures Publishing Co., 1978.
- Bomberger, Bruce D. "The Preservation and Repair of Historic Log Buildings." Preservation Brief #26. Washington, D.C.: National Park Service, 1991.
- Briscoe, Frank. "Wood-Destroying Insect." The Old House Journal, vol. xix, no. 2 (1991): 34-39.
- Canon, Peter. "Jacking Techniques for Log Buildings." Association for Preservation Technology Bulletin, vol. xx, no. 4 (1990): 42-54.
- Cotton, J. Randall. "Log Houses in America." The Old House Journal, vol. xviii, no. 1 (1990): 37-44.
- Hickin, Norman E. The Dry Rot Problem. London: Hutchinson of London, 1963.
- Hickin, Norman E. The Woodworm Problem. London: Hutchinson of London, 1963.

- Jordan, Terry. American Log Buildings: An Old World Heritage. Chapel Hill: University of North Carolina Press, 1985.
- Sickels-Taves, Lauren B. "McGuffey Birthplace, Greenfield Village: Historic Structure Report." Unpublished manuscript. Dearborn, MI: The Edison Institute, 1999.
- Sizemore, Jean. Ozark Vernacular Houses: A Study of Rural Homeplaces in the Arkansas Ozarks 1830-1930. Fayetteville: University of Arkansas Press, 1994.
- Upton, Dell and John Michael Vlach, eds. Common Places: Readings in American Vernacular Architecture. Athens: University of Georgia Press, 1986.

SUPPLIERS

Epoxy supplier:
WoodEpox by
Abatron, Inc.
5501-T 95th Ave.
Kenosha, WI 53144-7499
http://www.abatron.com

Oakum supplier:
Most stores carrying plumbing supplies

REFERENCES

National Center for Preservation Technology & Training
NSU Box 5682
Natchitoches, LA 71497
318-357-6464
http://www.ncptt.nps.gov
(Preservation Briefs are available on-line at the above web site.)

Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. Washington, D.C.: National Park Service, 1990.
http://www2.cr.nps.gov/tps/secstan8.htm

For a listing of conservators in your area as well as the above book, please contact:
The State Historic Preservation Office within the specific state.
A listing of SHPO addresses can be found at: http://www.ncptt.nps.gov/prog_pir_fs.stm

Note: The in-house conservation staff at The Henry Ford has developed these Preservation Fact Sheets to assist in caring for your historical materials. These fact sheets provide basic information on the care, cleaning, and handling of a particular type of artifact, referral information to other conservation organizations, and a bibliography of authoritative works. Individuals may also arrange for a private consultation with a conservator. For more information, please contact the Benson Ford Research Center at research.center@thehenryford.com.

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