AN ASSESSMENT FOR WOODEN OBJECT CONSOLIDATION: NOTES ON THE 1984 WAG/AIC THINK-TANK

Marc A. Williams
Chief Furniture Conservator
Conservation Analytical Laboratory
Smithsonian Institution

On December 1 and 2, 1984, the Wooden Artifacts Group of the American Institute for Conservation sponsored a think-tank on consolidation at the Klingle Mansion in Washington, DC. Its purpose was "to examine methods and ethical implications of current consolidation technology, attempt to define perfect consolidation, and establish potential means for achieving that goal." Ethical issues and assessment considerations were discussed heavily, but time limitations allowed only cursory investigation of currently used consolidants and perfect consolidation, and virtually no examination of practical means of approaching the ideal. In fact, the most striking result of the think-tank was the agreement among the participants that consolidation was not necessarily the treatment of choice for a deteriorated surface.

Arno Schniewind, of the Forest Products Laboratory, University of California, Berkeley, was the technical facilitator and James Wermuth, Furniture Conservator, Newport, RI, at that time Chair of WAG, served as referee. Other participants were: Walter Angst, Furniture Conservator, Silver Spring, MD; Stephen Brooke, Conservator, Maine State Museum, Augusta, ME; Steven Cristin-Poucher, Conservator, Los Angeles County Museum of Art; Michael Flanigan, The Kaufmann Foundation, Baltimore, MD; Nikki Horton, Conservator, National Museum of American History, Smithsonian Institution; Tom Robinson, Furniture Conservator, Philadelphia Museum of Art; and this author.

The following text was extracted from the author's notes shortly after the think-tank. (New research has been done since this time, most notably by Arno Schniewind, which has addressed some of the practical issues of consolidation treatment and reversibility.) For the most part, this paper reflects the consensus of the group, although personal prejudice of this author undoubtedly has crept into these pages. The information is presented in a modified outline form that will help flow-chart decisions with which a conservator is likely to be confronted. Many of the categories are listed in hierarchical order from least severe to most severe. This paper assumes that the object under consideration will be displayed in an interior environment. Objects in exterior environments may require additional considerations or a reordering of assessment priorities.

CONSOLIDATION is one process for treating biological, chemical or other deterioration of the materials composing a wooden object by impregnation with a liquid that is converted within the object to a solid. It normally accomplishes three major functions: arrests further deterioration, reattaches fragments, and strengthens. By the very nature of the process, consolidation is irreversible. Complete removal of even the most redissolvable material may be prevented by the physical resistance to solvent flow in the wood caused both by the cell structure of the wood and the barrier formed by the solid consolidant itself coating the cell walls, combined with the potential of solvent damage to transparent or pigmented coatings that may be present. For this reason, an investigation into the usefulness of consolidation must include an examination of alternatives. Toward this end, it would be helpful to outline an approach to analyzing damage to an object. This will be discussed first, followed by treatment options. Finally, specific ideal characteristics of a consolidant will be, listed and several currently used consolidants compared to this list.

Because of the uniqueness of each object and its condition, examination of damage to an object cannot be reduced to a recipe. It is hoped that the following list will provide a framework within which the conservator can make educated judgements.

I. **Cause of deterioration**. The agent of deterioration must be determined first. Check to see if it is active. The minimum acceptable treatment is inactivation of the deteriorative agent. Adhesion or strengthening may be necessary and the need will be determined by examination of other factors.

   A. Insects. The particular species should be identified if possible and the appropriate fumigation method chosen. It must be remembered that fumigation treatments kill only the existing life and possibly eggs and do not prevent reinfestation. It is currently felt by most conservators that residual chemicals pose too great a risk to humans to consider for use on objects. If total consolidation is chosen as the final treatment method, it is likely to kill the insects and their eggs and fumigation may be unnecessary.

   B. Fungi, including molds and mildew. Environmental control of the relative humidity to around the recommended 50% level will prevent further damage, provided there is not a water source, such as ground moisture, available to the fungi. Certain fumigants are effective also against plants, as are most consolidation treatments.

II. Severity of deterioration. Severe deterioration of one member of an object, while composing only a small percentage of the entire object, may cause severe instability. This is analogous to the weakest link of a chain causing failure of the entire chain. It is desirable, therefore, to examine each component separately to determine its severity of deterioration.

   A. Superficial. On or near the surface of the wood. The object is not in risk of collapse. Can occur in a surface treatment, such as paint or gesso. Generally, treatment, if necessary, consists of adhesion.

   B. Structural. The physical stability of the object is threatened. Generally, strengthening is necessary.

III. **Extent of deterioration.** The greater the amount of the object. or part that is deteriorated, the less likely that it will be stable without treatment.

   A. Limited. Only a small portion of the entire object or part is affected.

   B. Moderate. Up to about half of the object or part is affected.

   C. Extensive. Deterioration involves more than half of the object or part.

IV. **Location of deterioration.**

A. Primarx material. The surfaces of the object that were intended by the maker to be visible and the immediately underlying wood. Includes the shape, form, and surface appearance. If at all possible, primary material must be preserved.

B. Secondary material. Surfaces of the object and immediately underlying wood that were not intended by the maker to be visible, including under, behind, and inside the object. Should be preserved if possible but can be sacrificed if necessary for the preservation of primary material.

C. Tertiary material. The interior of primary and secondary components which is not visible without removal of primary or secondary material. Should be preserved also if possible but can be sacrificed for the preservation of primary or secondary material.

V. **Use of the object.** The treatment of an object should be based upon the concept of worst reasonable use, that is, the most severe conditions that the object reasonably will encounter. This is analogous to the l00-year flood plan of the Army Corps of Engineers. The treatment should not be designed for the worst imaginable conditions, but for the worst that reasonably is likely to occur. Overtreatment and overstrengthening should be avoided, as should be undertreatment. It is assumed that the minimum use of an object includes support of its own weight.

A. Controlled storage. The object will be in storage with controlled temperature and relative humidity, absence of light, pests, dust, and pollutants, and a minimum of handling. Potential deterioration of the object is minimized as is the necessary strength of the object.

B. Controlled exhibit. The object will be in idealized exhibit conditions similar to the above storage conditions. Necessarily, there will be more light and handling. As a result, potential deterioration is greater, as is the need for strength.

C. Uncontrolled storage or exhibit. One or more of the environmental conditions is not maintained. Additionally, the object may be used accidentally or in an emergency. Deterioration and necessary strengthening must be increased proportionally to the amount of departure from ideal conditions.

D. Controlled Use. The object will be used and must carry compounded stresses and withstand great deteriorative forces, but is in an idealized environment. The degree of use can vary considerably with the corresponding alteration of treatment needs.

E. Uncontrolled Use. The object is subjected to stresses of use while at the same time being aggressed upon by less-than-ideal environmental conditions. This is the most severe of allowable conditions of use. Unfortunately, it is often the most common for privately-owned objects. Treatment needs necessarily will be the most severe.

F. Abuse. Such conditions for an object are unacceptable and must be prevented. Education of the appropriate individual(s) should be undertaken rather than a more severe conservation treatment.

VI. **Type of treatment**. The necessary treatment depends upon careful consideration by the conservator of the factors discussed above. Treatment options are listed below in hierarchical order from least to most severe from the perspective of reversibility and of preserving the maximum amount of the fabric and integrity of the object. Aesthetics, for the most part, are not considered. The conservator must balance structural needs with the specific visual preferences of the curator or owner. It must be remembered that the object's physical integrity is of utmost importance.

A. Stabilization. The cause of deterioration is eliminated by the appropriate method, such as environmental alteration or fumigation. No adhesion or strengthening is undertaken.

B. Superficial consolidation. Consolidation with a redissolvable material provides an adhesive or attachment function and remains primarily on the surface of the object.

C. Exterior support. A support member or entire system is used to remove the stresses from a damaged member and distribute them in a manner that stabilizes the object. The support should be attached by gravity or removable methods that do not damage the integrity of the object. Destruction of original material generally is not acceptable. While it can be argued that exterior support can be visually disturbing, careful planning and choice of materials can reduce this problem.

D. Replacement and secure storage of original part. A new part is made and substituted for the original, which is attached if practicable to the object or placed in secure storage. Perhaps future technologies will allow treatment of the damaged part and its reattachment to the object. This treatment can be fully reversible. Complete "reproductions" can be made for extensively damaged objects. Original parts should be stabilized if necessary prior to storage.

E. Strength enhancement of original part.

1. Structural consolidation with reversible resin/solvent. The solvent evaporates, leaving a coating of resin on the cell walls. The voids in the cells and those caused by deterioration can not be completely filled. It must be understood that even if the resin is technically reversible, complete practical removal is impossible. Resin/solvent consolidation preserves the maximum amount of original material but will alter it characteristics and possibly its appearance.

2. Replacement of the deteriorated areas with new wood. This process causes the loss of original, although deteriorated, material. However, it causes little or no alteration of the original material's characteristics.

3. Replacement of the deteriorated areas with non-wood reinforcement. Can be stainless steel, carbon, or other material. May be surrounded by a buffering material to allow movement of wood against rigid reinforcement.

4. Structural consolidation with polymerizing system. A liquid is introduced into wood cells and catalyzed to form a solid. Examples include two part systems mixed before application, such as expoxies, and monomers catalyzed by radiation. These materials are not reversible and greatly change the characteristics of wood, including its appearance. Their long term stability is questionable and it is doubtful if retreatment can be done when they deteriorate. In addition, polymerization reactions are usually exothermic, and can cause severe heating and possible damage to the object.

It can be seen from the above prioritization of treatment options that structural consolidation is quite low on the list. This is because currently available consolidant materials do not possess adequate properties. It would therefore be useful to examine the ideal properties of a consolidant and compare existing consolidants to them. These ideals primarily are based upon consolidation of part, but not all, of an object. Under this circumstance, it is desirable for the treated area to behave and appear similarly to the untreated areas.

A. Provides necessary strength and/or adhesion. The strength of the consolidant should be equal to the original strength of the wood. Weaker risks failure of the member and greater strength can cause additional stresses and damage to other parts of the object.

B. Preserves physical characteristics of the wood. Does not alter the appearance, flexibility, resistance to creep, hygroscopicity or other characteristics of the wood.

C. Preserves chemical and biological characteristics of the wood. The consolidant also must be distinguishable from the wood.

D. Long-term stability. The consolidant should have resistance to deterioration equal to or greater than that of wood.

E. Ease and safety of introduction. The consolidation process must be accomplished easily with no damage to the object or to the conservator.

F. Removability. The consolidant must be dissolvable easily with solvents that will not harm the object or must otherwise be removable. In addition, removal from the interior of the wood must be practical.

G. Uniformity. The consolidant must not create stresses in the wood and must distribute itself evenly and completely in the deteriorated areas without concentration gradients. Ideally, the consolidant will penetrate only those areas that are deteriorated and not the unaffected wood.

Currently used consolidants can be divided into two basic groups, solvent/resin systems and polymerizing systems. Both types have considerable deficiencies when compared to an ideal consolidant. Solvent systems usually provide adequate adhesive strength for superficial consolidation. However, they generally are lacking adequate strength for structural consolidation. The resin deposited in the wood greatly affects the physical characteristics of the wood, including appearance (not generally a problem if the resin is reversible and can be removed from the surface), creep, and hygroscopicity. In addition, solvents can remove or redistribute soluble extractives of the wood, possibly affecting the color, and may dissolve finishes, paints and adhesives. With the proper resin choice, long term stability and redissolvability can be good. However, removal from the interior of the wood is impractical due both to difficulty of liquid diffusion in wood and to the sealing effect of the resin. Introduction of the solvent/resin system is at best difficult, generally resulting in concentration gradients from greatest at the surface to least at the interior caused by evaporation of the solvent. Vacuum impregnation, probably the most effective introduction method, is not practical with large objects.

Polymerizing systems generally are very strong, even to the point of exceeding the strength of the wood. The physical characteristics of the wood are changed severely, possibly resulting in the domination of the consolidant's characteristics over those of the wood. The long-term stability of the polymers formed is doubtful at best and removability impossible due to the harshness of solvents necessary for dissolution of the polymerized resin. This prevents removal of surface color change and darkening and globs of hardened consolidant that may have oozed from the interior during treatment. While introduction of the consolidant suffers from problems similar to solvent/resin systems, in situ polymerization leads more ever consolidant distribution since solvent evaporation gradients will not exist. However, polymerization reactions are exothermic and the heat generated can damage the object. Additionally, the great strength of the consolidant can create severe stresses in the wood and possible damage, especially when only part of an object is treated.

It is felt that the disadvantages of currently used consolidants generally are too great to use them as a common treatment. There will be, of course, occasions when no other viable option exists. It is hoped that the conservator will use cautious educated judgement at such times to chose the proper consolidant and treatment process.

Hope lies with the future. New materials and processes are being developed at an ever-increasing rate and it is reasonable to assume that the conservator will have much better consolidation options in the not-too-distant future. Industry will be the inventor of most of these processes and materials. For this reason, it is advantageous for conservators to form ties with appropriate commercial chemists and wood technologists to help speed the transfer of information to our profession.