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Wooden Artifacts Group Postprints

Presentations from the 2009 AIC Annual Meeting in Los Angeles, California
Wooden Artifacts Group Sessions

Wooden Artifacts Group

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POSTPRINTS OF THE WOODEN ARTIFACTS GROUP SESSION
ANNUAL MEETING

2009 WAG INDEX

2009 WAG ABSTRACTS (WRITTEN PAPER NOT SUBMITTED)

WILLIAM RALSTON

Shop Considerations: Epoxy-Carbon Fiber, Utility and Retreatability

INCREASINGLY— I have found carbon fiber–reinforced epoxy to be the best way to add needed strength to broken or weakened furniture. The high tensile strength and the ability to spread the load evenly over a relatively large area (compared to the point loading of fasteners) are often crucial qualities needed for a successful repair. What follows is a sampling of situations where I believe this method is the best alternative.

One general type of problem that can best be repaired using epoxy/carbon fiber is where there is high loading across the grain of the wood causing it to split. The first time I used epoxy in such a situation was on a very large neoclassical (or Duncan Phyfe–style), single pedestal, four-legged table. The problem was out near the ends of the legs where they were smallest in cross section and the grain ran at a sharp angle across the leg. An extreme example of this is the bottom leg in fig.1 where the red lines show the grain direction in the legs as laid out on a board. The legs had originally broken a little back from the casters. Earlier repairs glued the leg(s) back together and added an iron strap screwed to the underside of the legs, not an uncommon fix. But in what appeared to be a second repair on two of the legs, someone had drilled into the ends of them for half a dozen inches or so and inserted large reinforcing dowels (fig. 2. The red line on the left indicates the break along the grain of the wood). When the table came to me, the legs had not just broken again, this time at about the right hand red line, but shattered into tiny little fragments around the dowel. The iron reinforcing straps had ultimately proved inadequate, too, and one of the other legs had broken again at or near the original break. I started by repairing things using hide glue. I carefully put everything back together as best I could. But no amount of hide glue or wood patching was going to fix the old repairs and get me back to the strength of the original legs, which, even when pristine, had proved inadequate to their task. So I made a wood support to fit under the pedestal column to take the weight of the table off the legs. But I felt that the legs were no longer even strong enough to act as lateral stabilizers. So I routed a shallow groove in the underside of each leg starting from the point where the grain ran parallel to the leg out to the tip where it was running across the leg. Then I epoxied lengths of carbon fiber in the groove (as indicated by the blue line in fig. 3). Carbon fiber is exceptionally strong and rigid under tension, and running on the underside of the legs, provided the necessary reinforcement. In hindsight, I did not need to route a

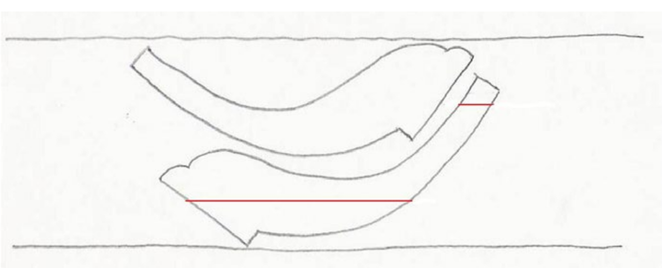

Fig. 1. Two possible layouts of pedestal legs on a board. Grain direction is always problematical in curved pieces. The red lines show the general grain direction. The bottom leg layout is an especially poor choice. It will be very weak near the foot due to the short grain.

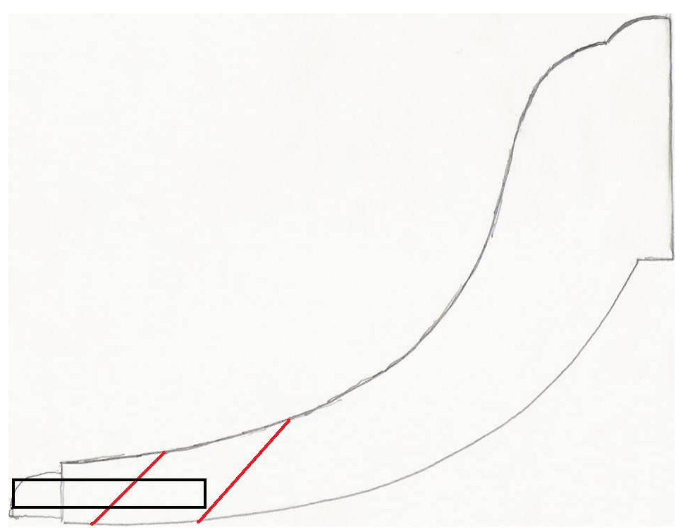

Fig. 2. Previous repair to pedestal leg showing one break along the grain (left red line) reinforced by a dowel (black) which led to a second break (right red line.)

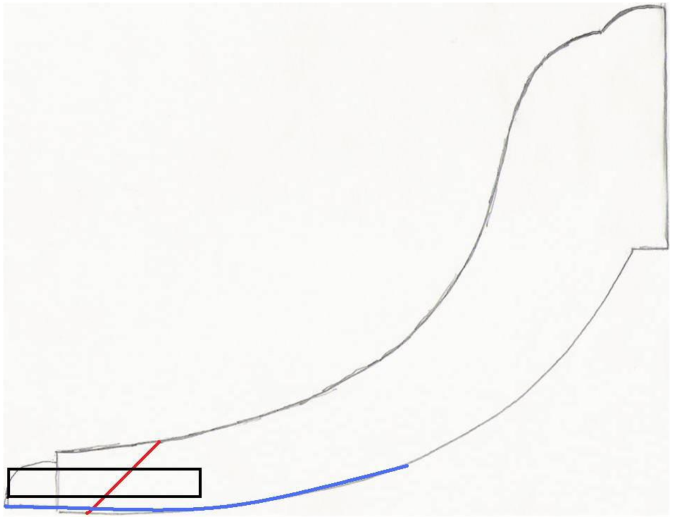

Fig. 3. Reinforcement of pedestal leg using a strip of carbon fiber-reinforced epoxy (indicated by the blue line) on the underside of the leg.

groove except to give clearance for the caster. While the epoxy itself is not reversible, this repair (without the groove) is more reversible and less invasive than doweling and certainly no worse than drilling a bunch of screw holes for an iron strap, and it is far stronger than either. Another situation again involving a table pedestal, where I strongly believe epoxy/carbon fiber to be the repair of choice, was to reinforce the leg/column joint. I first thought of this use while repairing a piece which, like the preceding example, had undergone a number of earlier repairs of varying quality and, in addition, had also been underbuilt to begin with. I first had to re-repair the legs themselves. Figure 4 shows the typical grain direction and where the leg had split. A previous repair inserted reinforcing dowels (indicated by the white line in fig. 5), but as seen by the open split in figure 5, these had obviously failed. I reglued the legs as best I could with hide glue and then routed a very shallow groove and epoxied carbon fiber into the groove as shown in figure 6. The pedestal column had also split and had been reinforced by dowels at some point (figs. 7, 8). This too I reglued as best I could with hide glue. But I needed a way of reinforcing the leg/column

Fig. 4. Pedestal leg showing grain direction in upper leg (indicated by white lines) and resulting split (arrow). This layout is the opposite of the bottom leg in fig.1. Very possibly the maker wanted to give maximum strength to the foot end of the leg, thinking that the column would help strengthen the short grain in the upper part. Not a bad thought, but in this case it didn't work.

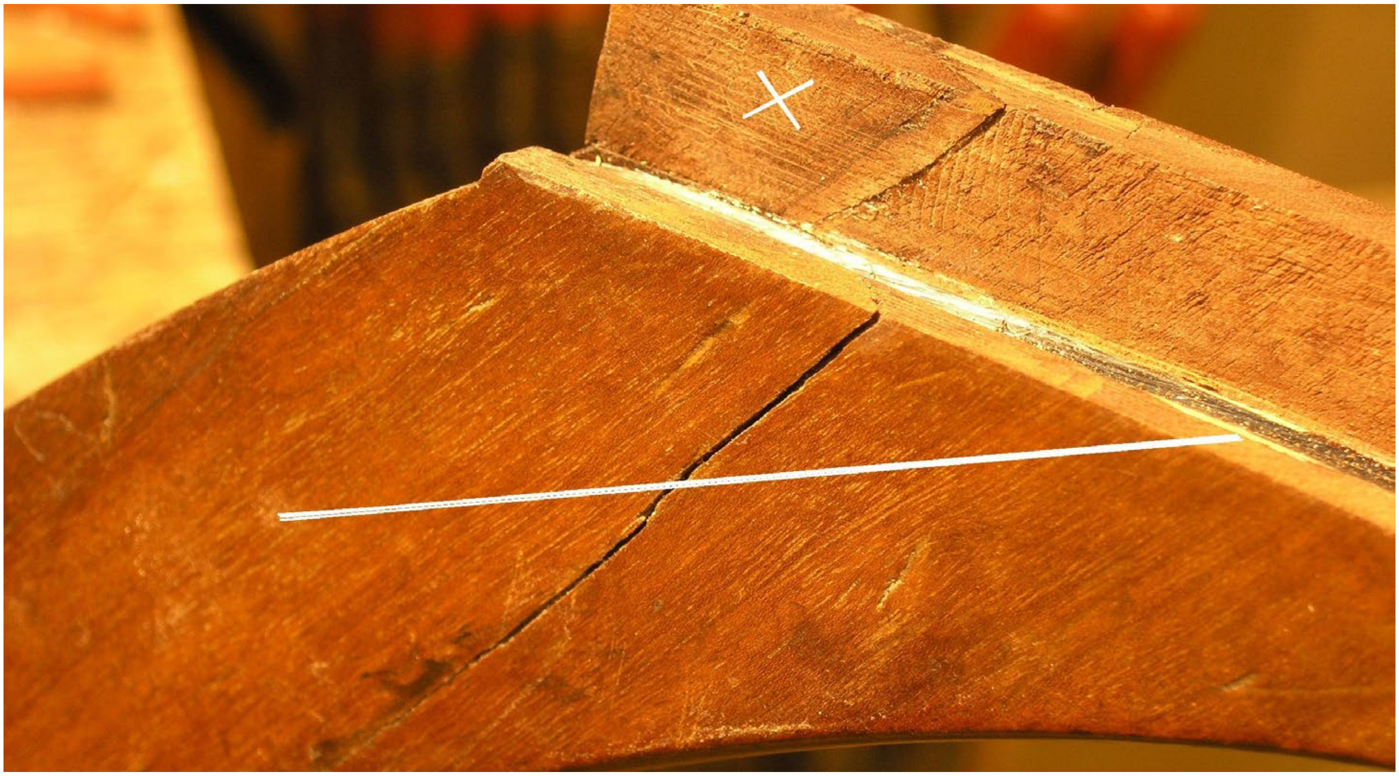

Fig. 5. Pedestal leg showing the failed repair which used a dowel (indicated by the white line) to reinforce the short grain.

dovetail joints. The traditional repair for this problem is a fitted metal strap, looking a bit like a three- or four-legged spider, which is screwed to the bottom of the column and the undersides of the legs. But there is little strength gained in the horizontal plane, since there usually is hardly more of the leg lying in the horizontal plane than the dovetail itself to screw into (fig. 9). A screw hole here greatly weakens the dovetail and with the sideways, that is, horizontal, load on the screw, it acts as a lever to break the dovetail off. (In figure 5 the "x" marks just such a spot that had been patched previously.) The other screws along the downward sweep of the leg do little or nothing unless the fasteners and the metal are utterly rigid—a dubious assumption. To see if epoxy/carbon fiber might make an adequate repair I made a dummy column and leg and, merely butting them together, I epoxied carbon fiber across the "joint" (figs. 10–12). The epoxy/carbon fiber could hold 145 pounds (myself)

Fig. 6. Reinforcing the leg with strips of carbon fiber-reinforced epoxy in shallow grooves.

Fig. 7. Bottom of the pedestal column showing cracks where the stress on the legs split the wood. The 5 holes are from the screws holding a reinforcing metal plate. The white circle (arrow) is the end of a dowel from a previous repair to strengthen the column.

Fig. 8. Another view of the pedestal column with the dowels from a previous repair.

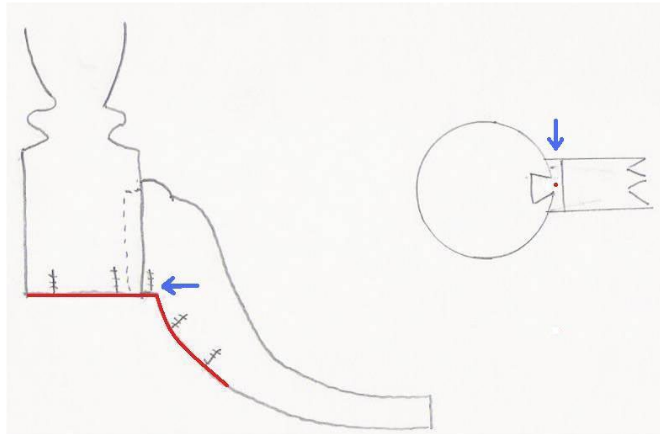

Fig. 9. Shows typical screw locations when using a metal reinforcing plate (red line.) The screw indicated by the blue arrow tends to break off the leg's dovetail.

Fig. 10. Set up of a trial testing the efficacy of a carbon fiber-reinforced leg/column joint. The carbon fiber is the only attachment between the 'leg' and 'column' . Nevertheless it held 145 pounds hanging from the end of the 'leg'.

Fig. 11. Close up of the trial in fig. 10. The white rectangle is explained in the text.

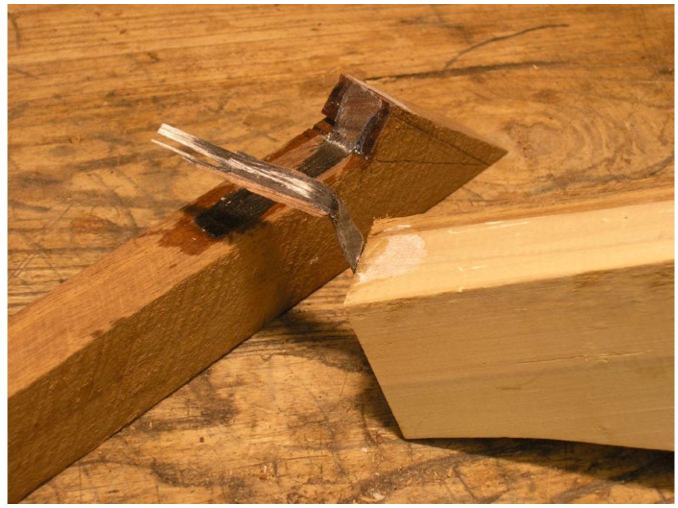

Fig. 12. The failure of the trial in fig. 10 after the carbon fiber was detached from the leg as explained in the text.

hanging on the end of the leg. As I expected, when I broke the epoxy bond to the leg in the area indicated by the white outlined rectangle (fig. 11), all strength was lost. Not wanting to rely on just that small area for the actual repair I decided to drill a small, more or less horizontal, hole into the underside of each leg at the level of the column base. I wet the hole and a shoelace-sized strand of carbon fiber with epoxy. Using a small notched sliver of veneer as a pusher, I shoved the middle of the strand all the way into the hole, leaving both ends of the carbon fiber sticking out (perhaps 3-5 inches depending on the size of the column). I fanned the carbon fiber out a little, and epoxied it to the bottom surface of the column (figs. 13, 14). (The light gray areas in fig. 14 are where

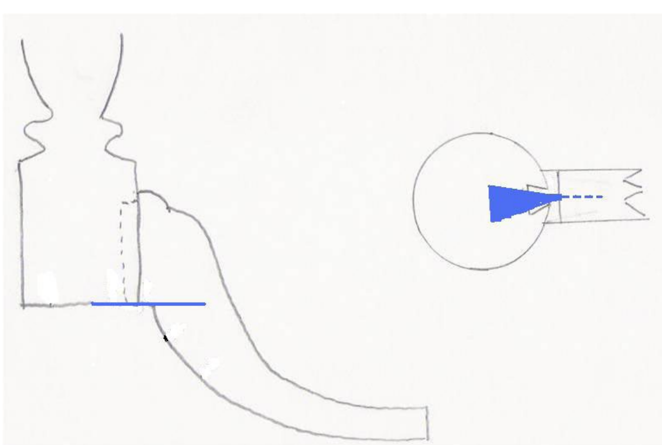

Fig. 13. Showing the placement of the carbon fiber-reinforced epoxy used to strengthen the leg/column joint.

I unfortunately sanded the epoxy/carbon fiber smooth before taking the photo.) The hole in the leg needs to be no more than a quarter inch in diameter, so it has almost no effect on the strength of the leg. In contrast to the metal spider, the hole for the carbon fiber is into the main body of the leg, not the dovetail. There is a sufficient amount of bonding area between the carbon fiber and the wood of both the leg and column for the repair to be quite effective. This repair has virtually no negative consequences and I believe is effective enough even to be used as a preventative whenever strength is questionable.

Another important use of epoxy/carbon fiber is as a reinforcing band around a weak spot. In my experience, this occurs most often where a dowel has been inserted into a broken turning. For example, when turned legs have snapped off or chair stretchers have broken. Figures 15–22 show the repair of an insect damaged chair leg and stretcher that I repaired in this way. Another common situation is where turned chair legs have been ended out and the old leg splits around the dowel.

A less common situation is a repair I did on a hoop-back Windsor chair. One end of the hoop had snapped off where it entered the seat. A previous repair had added a new tenon onto the end of the hoop using a short scarf joint. The workmanship was good, but the scarf was much too short to hold. Over the course of a few years, I reglued the pieces two or three times. This last time, after I had glued the scarf joint back together yet again, I decided to wrap the joint with a band of epoxy/carbon fiber. That was not too long ago, so I haven't gotten any feedback, but I'm confident that it will last a long while. The only alternative was to replace the old patch with

Fig. 14. The bottom of a repaired pedestal showing the carbon fiber-reinforced epoxy strips used to strengthen the legs as well as the leg/column joint.

a new one having a longer scarf joint. That would have meant removing even more wood from the original hoop. The epoxy/carbon fiber was certainly the lesser of evils and a more effective repair too. This chair happened to be black so the repair blended in nicely. In other situations it would, of course, require painting.

One last example of using epoxy/carbon fiber is a recent repair on a Hitchcock chair (figs. 23–26). The rear leg had snapped where the two seat rails entered it. A previous repair had mortised in a spline but this had broken also. The repair had been well done but was just not strong enough. I dug out the old spline, glued the leg together, fit and glued in a new spline, and then epoxied two small unobtrusive strips of carbon fiber across the break on the front side of the chair. Their tensile strength and resistance to elongation should add a great deal of strength against someone leaning back in the chair. (The carbon fiber strips pictured were too short and came unglued in about 2012. I redid the repair using wider, longer strips. So far, so good.)

These are some of the situations I've encountered where epoxy seems to be the most conservative choice. Though the glue itself is not reversible, the techniques are nearly so. And when compared to the alternatives, they are often more so. In situations where a point of stress could be fatal, carbon fiber spreads the load and can be feathered out to decrease the strength gradually, something impossible with fasteners and often difficult with other techniques. These are structural repairs, where a weaker alternative could well lead to more breakage, which is inherently irreversible.

Fig. 15. Underside of a Windsor chair where the insect damaged leg snapped off.

Fig. 16. The end of the leg of fig. 15, showing insect exit holes.

Fig. 17. Turned plug to fit into the leg end and the chair seat.

Fig. 18. The plug inserted into the bottom of the chair seat and a dowel ready to be inserted into the end of the broken stretcher.

Fig. 19. Another view of the prepared leg and plug.

Fig. 20. The leg glued in place. A ring of finish has been sanded off in preparation for the band of carbon fiber-reinforced epoxy.

Fig. 21. Bands of carbon fiber-reinforced epoxy on the leg and stretcher.

Fig. 22. The finished repair with the carbon fiber bands colored to match the chair finish.

Fig. 23. Hitchcock chair with a broken rear leg. The clamp is pushing the leg into alignment.

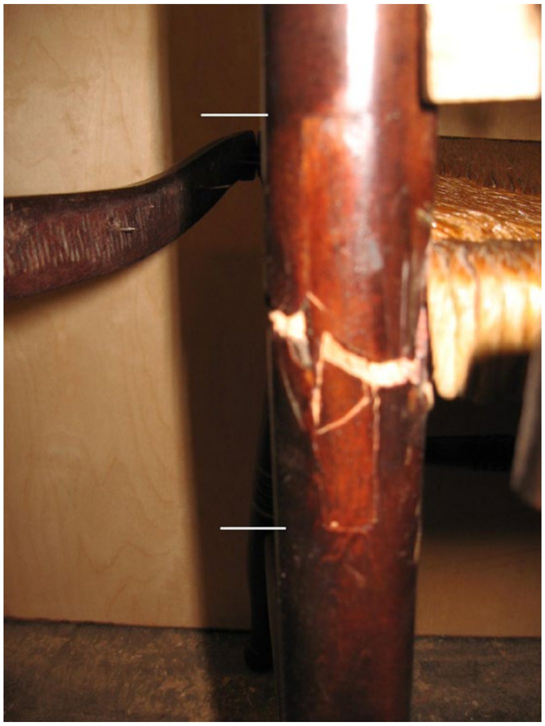

Fig. 24. Chair leg with the broken spline from a previous repair. Slightly out of focus unfortunately.

Fig. 25. The finish scraped off the front of the leg in preparation for gluing on carbon fiber reinforcing strips.

Fig. 26. Carbon fiber reinforcing strips glued on. They will be colored to match the chair.

AUTHOR BIOGRAPHY

After a brief stint as a high school science teacher, Bill Ralston began his furniture making career by working eight years under a German Master Craftsman, who ran a small shop employing about a dozen people including several other European craftsman. The shop specialized in reproducing high style 18th Century American antiques. Bill learned to work to the exacting standards set and perpetuated by the guild system which still exists in Europe. In 1979 he opened his own shop in the village of Cherry Valley, NY. Two years later he moved to nearby Cooperstown. He has continued to reproduce high style 18th century American antiques with an emphasis on neoclassical Federal furniture. He developed a second specialty when he did a series of commissions in the Gothic and Gothic Revival styles for a monastery, and later, for Lyndhurst, a National Trust for Historic Preservation site in Tarrytown, New York.
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A Method of Acoustic Detection of Wood-boring Insect Larvae

ABSTRACT—Detection of the presence of activity of plant-eating insect larvae is indispensable for the selection of a plan of action for the treatment of infested wooden structures or furniture. Craft Inadec developed a prototype detector capable of diagnosing on site the presence of termites. Insufficiently sensitive, the systems of acoustic detection available on the market are not adapted to detect *Anobium punctatum* and *Lyctus brunneus*, the woodboring beetles which are most often found in infested furniture.

Work over the past seven years has achieved the following: the definition and acquisition of a true insect acoustic signal; the study of the acoustic signals emitted by the larvae of the xylophages being researched; the study of different systems for the treatment of the signal; the development of a useful system in real cases for recording the area of activity; and different levels of recording were tested by *Laboratoire de recherche des monuments historiques* to obtain a "true" signal.

The next stage of research must include a definition of the limits of detection of the apparatus; further analysis of the data by experts in insect infestations and comparison with other, more classic methods of detection, in order to develop rules of interpretation which can be integrated into a logical approach to detecting and treating insect infestations; and the integration of these rules into an approach that is useful in real situations.

It will be possible to envisage the creation of an enterprise with a dedicated, portable apparatus, which is simple to use and which can be used in a systematic way in the field to both promptly detect infestations and monitor against them over the long term.

Le diagnostic de l'infestation des bois secs reste aujourd'hui très difficile à réaliser. Le développement des larves d'insectes xylophages se déroule dans le bois et n'est pas perceptible de l'extérieur. Le cycle de développement est long. Selon les espèces il peut varier de 1 à 5 ans (Figure 1). Le diagnostic avant traitement est uniquement réalisé par un contrôle visuel : forme des trous d'envol, présence de sciure, présence d'adulte. L'ensemble de ces observations conduit souvent l'expert à proposer un traitement « de précaution » voire à titre préventif. Un traitement (anoxie, traitement en phase liquide) est alors entrepris parfois systématiquement sur des œuvres où des trous d'envol sont observés. Ainsi le traitement ne devrait souvent pas être nécessairement entrepris. De plus, il est impossible de contrôler son efficacité. Actuellement, le propriétaire de l'œuvre ne peut que s'en remettre à l'assurance de l'entreprise de traitement qui a dû suivre les prescriptions d'usage.

Ainsi, un système de diagnostic de la présence d'activité de larves xylophages dans le bois sec peut d'une part éviter bon nombre de traitements, et d'autre part, permettre de vérifier l'efficacité des traitements effectués.

Le principe de la détection acoustique d'insectes n'est pas nouveau ([1], [2]). Il s'agit d'enregistrer les vibrations émises par les larves dans le bois. Cette méthode a déjà montré son efficacité pour la détection des termites et des capricornes des maisons (INADEC©). Par ailleurs, dans d'autres domaines que le bois ce type d'outil a été développé, notamment pour la détection des insectes altérant les denrées stockées (EWD©). L'ambition de cette étude est de déterminer si un appareil peut permettre de détecter la présence de larves xylophages (type *Anobium punctatum, Oligomerus ptilinoides, Lyctus Brunneus*).

La bibliographie nous informe que la propagation des vibrations dans le bois a largement été étudiée notamment dans le cadre de recherche sur le contrôle non destructif du matériau. Ainsi, des méthodes font appel aux ultra sons ou aux vibrations pour mesurer un taux d'altération du bois. Quelque soit la méthode, il s'agit d'émettre une onde et de mesurer les caractéristiques de l'onde transmise pour déterminer le taux d'altération. Dans tous les cas, il est nécessaire d'effectuer un traitement du signal transmis pour pouvoir conclure sur le taux d'altération. Ces études nous apportent un certain nombre d'informations intéressantes :

- l'onde est mieux transmise dans la direction longitudinale ;
- la vitesse d'une onde ultrasonore dans la direction longitudinale est de l'ordre de 3600 à 5100m/s (dépendant de l'essence de bois);

Pour notre étude, nous avons commencer par définir et optimiser un système d'acquisition [3] (commercialisé, léger, transportable, facile à mettre en œuvre), dans le même temps nous avons

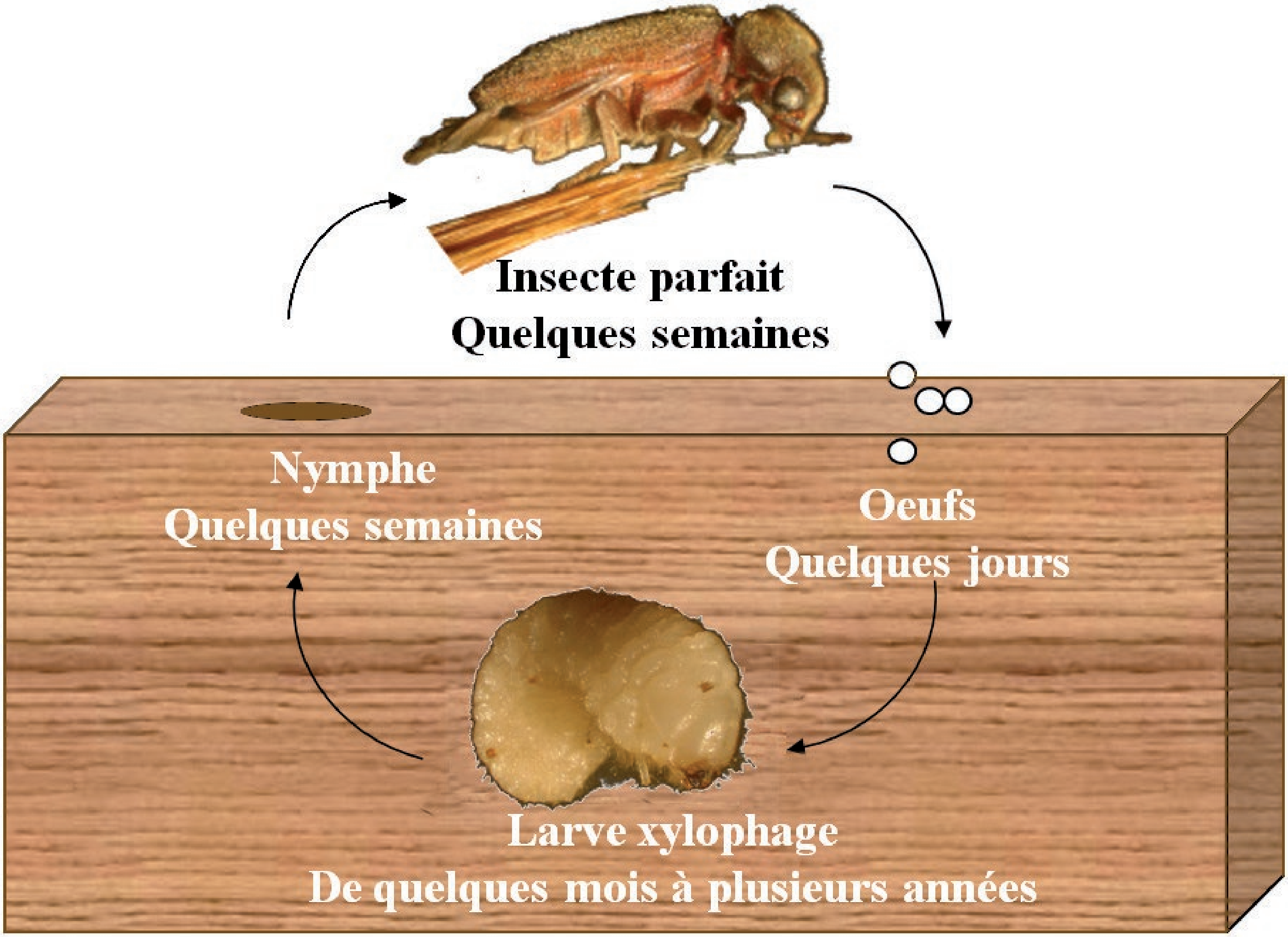

Fig. 1. Cycle de vie des insectes

tenté de caractériser le signal émis par les larves (*A. punctatum*, *Oligomerus ptilinoides, L. brunneus*) enfin un traitement du signal a été mis en œuvre afin d'optimiser la détection. Les premiers résultats apportés par l'appareil sont présenté en fin d'article.

Les premiers enregistrements ont été effectués en utilisant des élevages d'insectes. Pour *Lyctus brunneus*, il s'agissait d'élevage dans des blocs en aubier de chêne. Ce que nous connaissons sur les cycles d'activité de ces larves est relativement succinct. Dans les meilleurs conditions de développement, les larves de *Lyctus* ont une durée de vie de six mois minimum. Il est impossible de transposer les larves d'un bloc de bois vers un autre.

Pour *Anobium punctatum* et *Oligomerus ptilinoides,* il s'agissait d'élevages dans des blocs en bois de résineux. Ces larves d'anobidés ont dans les meilleures conditions de développement une durée de vie de un an minimum. Il est possible de transposer les larves d'un bloc de bois vers un autre. Cette possibilité sera utilisée lorsque nous étudierons l'impact du nombre de larves sur les vibrations enregistrées.

Le système d'acquisition est présenté sur la figure 2. Il est constitué de :

- un accéléromètre (PCB 352C65 type piezoelectric detection Bruel and Kjaer accelerometers, with a bandwidth close to the 20 Hz – 20 kHz audible range …),
- une carte d'acquisition 01dB symphonie,
- du micro ordinateur équipé d'un logiciel d'acquisition vendu par la société 01dB-Metravib,
- des écouteurs.

Le signal est enregistré dans une gamme de fréquence comprise entre 20 Hz et 20 kHz par l'intermédiaire du logiciel 01dB Trig vendu avec la carte d'acquisition. Enfin, dans un première phase de l'étude, le signal est analysé grâce au un logiciel (01dB Trait) lui aussi vendu avec la carte d'acquisition.

Des signaux émis par les larves ont pu être enregistrés. Ils correspondent à des transitoires, clics de quelques milli-secondes et

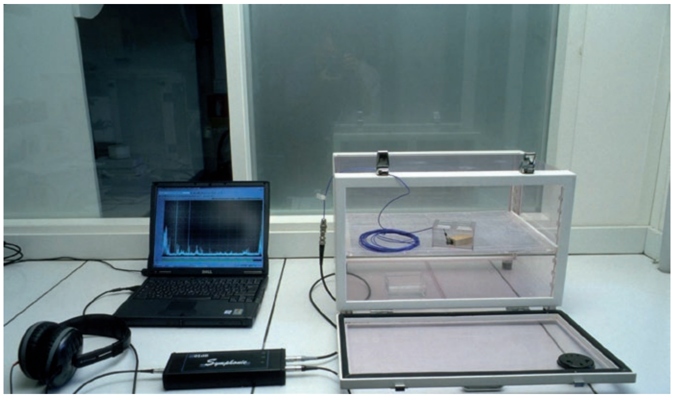

Fig. 2. Système de détection acoustique des larves xylophages (un accéléromètre, une carte d'acquisition 01dB symphonie, micro ordinateur équipé d'un logiciel d'acquisition vendu par la société 01dB, des écouteurs)

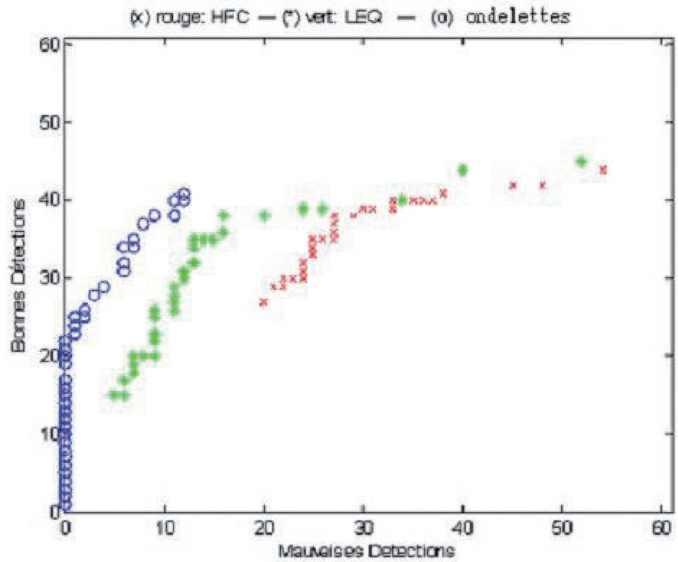

Fig. 3. Signaux acoustiques détectés par le système d'acquisition

d'amplitudes variables. Ils peuvent être audibles (après amplification) (Figure 3). Il est probable que ces transitoires soient dues à la rupture des fibres du bois sous l'action des mandibules des larves et peut être même aux mouvement des larves. Nous avons pu constater une grande variabilité dans les enregistrements que nous avons effectués. Nous distinguons différents critères de variabilité selon :

- le stade d'évolution des larves à l'intérieur du bois qui peut être très variable. Tout d'abord, les larves ont une taille comprise entre environ 0,5 et 2,5mm. Il est probable qu'en fonction de leur taille, les larves produisent un signal acoustique différents. Par ailleurs, au cours de leur développement dans le bois les larves ont des périodes de mue où elles sont quasiment immobiles et, ne mangeant pas, ne produisent probablement pas de vibration.
- Les conditions climatiques influent directement l'activité des larves. Par exemple, à une température inférieure à 20°C leur activité se ralentit.
- Le nombre de larves dans le bois a, comme nous le verrons plus loin, un impact sur le signal enregistré.
- Enfin, selon les espèces, le signal enregistré est différent : chaque espèce a un rythme d'activité différent. Cela a été notamment observé sur des enregistrements de *Lyctus* par rapport aux enregistrements d'*Anobium*.

A ce stade de notre étude, les enregistrements étaient analysés par le système le logiciel 01dB trait qui ne permet pas une analyse fine du signal : le rapport signal sur bruit est faible. Il est très probable qu'avec ce type d'analyse un certain nombre de transitoires sont perdues dans le bruit de fond. Il est donc apparu nécessaire de procéder a un traitement du signal enregistré.

Pour cela, nous avons développé sous MatLab un système de traitement du signal « off line ». Le signal a été tout d'abord « débruité » en utilisant une transformée par ondelettes. Différents événements émergeant du bruit sont alors détectés :

- des signaux transitoires réellement émis par les larves,
- des événements aléatoires, artéfacts dus au bruit inhérents à tout enregistrement acoustique ,
- Des événements acoustiques réels dus à d'autres sources que les larves (portes, pas, voix,…).

Ces différents événements ont été classés en se basant sur un réseau de neurones. Pour cela 4 paramètres basés sur le signal temporel et le spectre (caractéristique) fréquentiel ont été déterminés pour caractériser les événements acoustiques :

P1 – Rapport signal sur bruit

P2 – Kurtosis

P3 – Rapport Maximum sur seuil

P4 – Largeur temporelle maximale

A partir de ces différents paramètres, il a été possible de discriminer les événements acoustiques réellement dus aux larves.

Ainsi, l'enregistrement préalablement effectué sous 01 dB Trig est traité par le logiciel développé. Les informations obtenues sont les suivantes :

- la localisation des clics par rapport à la période d'enregistrement ;
- la visualisation de la forme de l'onde de chaque transitoire ;
- la courbe d'activité de la larve ;
- la possibilité d'écouter l'enregistrement avec un casque audio.

Pour éviter d'avoir de trop gros fichiers à traiter, nous n'effectuons pas d'enregistrement de plus d'une heure

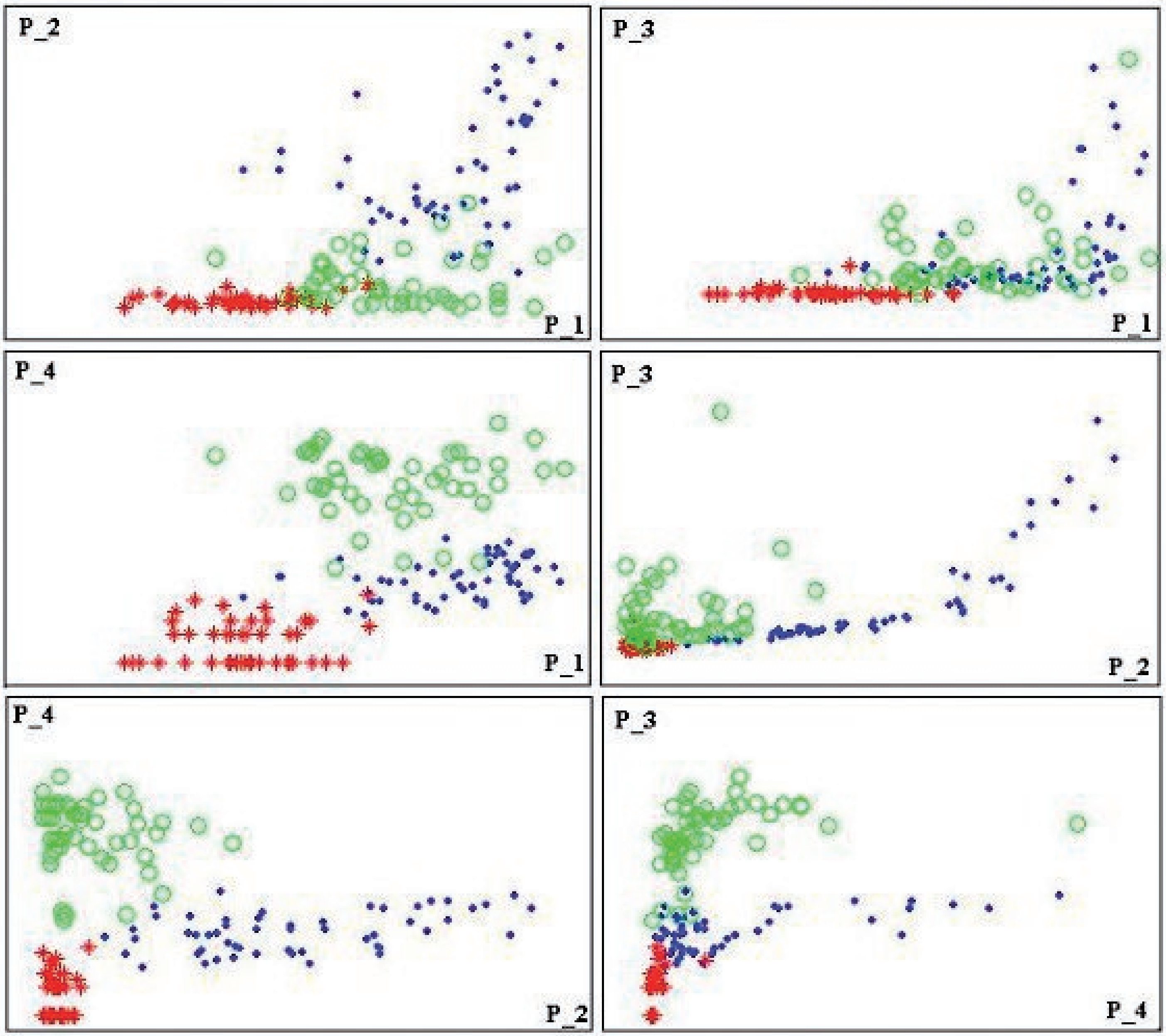

Fig. 4. Spectres de l'activité d'une larve xylophage dans un bloc de bois pendant 24h ; chaque spectre a été enregistré pendant une heure sur deux.

consécutive. Le temps de traitement du signal pour une heure d'enregistrement dure 5 à 10min.

Le développement de ce logiciel, nous a permis de suivre et d'étudier l'activité biologique d'une seule larve dans un morceau de bois. Une larve (*Oligomerus ptilinoides*) a été déposée dans une cavité d'un bloc de bois de résineux recouverte par une lame de verre. Après avoir fixé un accéléromètre sur le bloc, l'ensemble est placé dans une chambre noire (les larves étant lucifuges).

Les enregistrements sont effectués une heure sur deux pendant 24h (Figure 4). Si les graphes présentent des spectres d'activité différents, il n'y a pas de différences significatives sur le nombre de clics des spectres enregistrés le jour ou la nuit.

La Figure 5 montre les distribution temporelle des transitoires de deux larves placées chacune dans un bloc différent. Les activités ont été enregistrées simultanément sur une même période pendant un mois. Lors de la première semaine d'enregistrement, les deux larves ont des activités équivalentes. Après une semaine, on constate que l'activité de la larve 1 a fortement ralentie, alors que la larve 2 est muette. Après un mois, un nouvel enregistrement montre que la larve 1 est à son tour

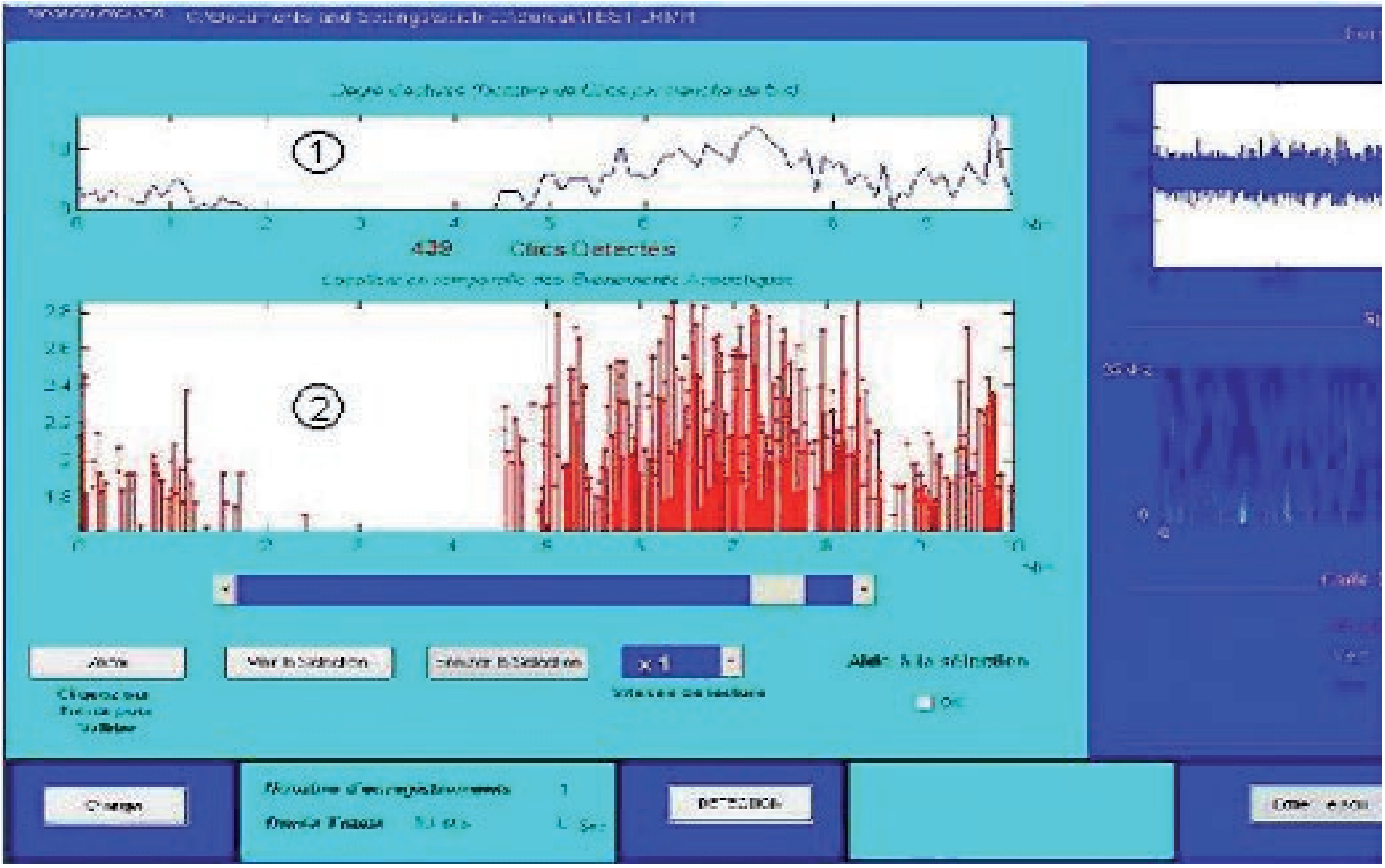

Fig. 5. Spectre de l'activité de deux larves xylophages chacune dans un morceau de bois ; les enregistrements ont été effectué à différentes périodes pendant un mois.

muette alors que la larve 2 a repris son activité. Ce type d'enregistrement pourrait être interprété par le fait que la larve 2 a muée pendant le mois d'enregistrement. Cela tendrait a montré que lorsque l'on ne détecte pas d'activité il est nécessaire de prolonger le contrôle sur des périodes régulière pendant un mois pour s'assurer de la présence ou de l'absence d'activité. Ceci doit être encore étudié et nous resterons prudent sur ce type de conclusion. En effet, la durée de la mue, sa fréquence, doivent dépendre en particulier des conditions environnementales, de l'âge de la larve, de la nature du bois.

Un essai a été effectué sur un bois naturellement infesté. Cet enregistrement s'est avéré particulièrement riche en clic d'insecte. Cela semble logique : une infestation se traduit en général par le fait qu'il y a plusieurs larves dans le bois ; chacune de ces larves a une activité propre mais, statistiquement, il y en a toujours une pour émettre une vibration.

En conclusion, nous avons développé un appareil qui permet de détecter les vibrations émises par des larves xylophage**s** dans du bois sec. L'outil présente une bonne sensibilité puisqu'il est possible de détecter l'activité d'une seule larve. Notre appareil reste aujourd'hui un appareil expérimental dont il faut poursuivre la validation. : les temps d'enregistrement nécessaires au diagnostic reste inconnus ; les conditions d'enregistrements doivent être mieux définies (température et humidité) ; l'application à d'autres espèces xylophages doit être étudiée. Du fait des informations encourageantes recueillies lors des derniers enregistrements, il reste aussi à entreprendre le développement d'un traitement du signal « on line » afin de limiter les temps d'analyse et d'optimiser l'outil diagnostic.

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AUTHOR BIOGRAPHY

EMMANUEL MAURIN is a wood engineer at the *Laboratoire de recherche des monuments historiques (LRMH)*. He received his PhD from the University *H. Poincaré* of Nancy (1996) entitled "*La modification chimique du bois—Méthodologie de synthèse et recherche de nouvelles propriétés biologiques ou physico-chimiques*" ("The chemical modification of wood—Methodology of Synthesis and Research of new Biological and Physico-Chemical Properties"). Since 1998, he is in charge of the wood department of the LRMH (http://www.lrmh.fr/Wood.html?lang=fr). This scientific division responds to requests from the *direction de l'Architecture et du Patrimoine* (Architecture and Cultural Heritage) and of the *direction des Musées de France* (French Museums). Topics covered include movable wooden artifacts (furniture, statues) and wooden structures. The scope of prospecting being considerable, studies and research are usually carried out in partnership with other organizations (public laboratories or private centers of study). The current research themes focus on condition report and diagnosis as well as on conservation methods (reinforcement, disinsectization). Case studies regarding these have also been carried out.

KATHY Z. GILLIS

Inspired by the French—American Partnership: Louis Majorelle Furniture Treatments at the Virginia Museum of Fine Arts

ABSTRACT—In 2006, the French Ébéniste-Restauratrice, Anna Østrup came to study and advise on the Art Nouveau Furniture in the Lewis Collection of Decorative Arts at the Virginia Museum of Fine Arts (VMFA). While all of the Majorelle furniture at the VMFA was examined and microscopy samples were analyzed for the project, the bed in the bedroom suite stood out as it appeared to have undergone some substantial alteration since its original design and fabrication. This prompted a more intense study of the VMFA bed and other similar beds by Majorelle, leading to a conservation project that would address these issues.

Anna, a furniture conservator from Paris, who specializes in Art Nouveau furniture, came to the Virginia Museum of Fine Arts (VMFA) to examine a group of furniture in the Sydney and Frances Lewis Decorative Arts Collection. The majority of the pieces in this collection were given to the museum in 1985 by Sydney and Frances Lewis, who made their fortune in the Best Products Stores and had generously contributed (along with Paul Mellon) to the building of the West Wing of the VMFA, which opened in 1985. Along with their collection of modern and contemporary art, the Lewises gave the museum nearly 600 pieces of furniture and decorative arts from the late 19th and early 20th centuries that they had begun collecting in the 1970s. Our holdings constitute the largest public collection of furniture from this period in the United States.

Anna was in America from April 21 through May 3, 2006, both to participate in the FAP Symposium held at Winterthur Museum, and to give a demonstration for DVD taping of 18th century furniture polishing techniques at the University of Delaware. She also visited, with several other FAP participants, Maymont, a historic house in Richmond, whose holdings include works by Louis Comfort Tiffany and Louis Majorelle, and Monticello, the iconic home of Thomas Jefferson.

From the VMFA's collection, Anna and I examined fourteen pieces of furniture. These date between 1896 and 1910, and with the exception of one desk by Victor Horta (Belgian), all were designed and/or fabricated by the French masters of Art Nouveau, Louis Majorelle and Émile Gallé. Among the subjects was one of the masterpieces of our collection: a suite of furniture by Louis Majorelle designed and produced in or prior to 1909 (fig. 1).

This suite first appears in the publication Arts et Industrie from 1909 (fig. 2). Not only is the suite an impressive example of Majorelle's work, but, as far as I know, no other institution (or private collection) owns as complete a set. This period photo shows what is very likely our suite, as all the pieces in this image are in our collection, with the exception of the fireplace mantle. The Musée d'Orsay in Paris has a bed and nightstand in the same design and another bed, two nightstands, and a slightly different armoire are in the collection of The Musée des Arts Décoratifs et de L'art Moderne in Gourdon, France.

At the time of Anna's visit, the Majorelle Bedroom Suite had been on view for over 20 years in our galleries and had not been closely examined (except for a brief condition survey in 1999) or treated in any fashion. Anna and I examined the surfaces of all the pieces and determined through visual assessment that all of the components of the bedroom suite had been through a refinishing process probably at the hands of dealers in the French antique market in the 1970s, prior to entering the Lewis collection. Very limited information exists on any work done to the furniture prior to acquisition by the Lewises. Fortunately, there are clues on the furniture itself that can provide evidence of what it has been through. We were able to gain a great deal of information from examining the pieces with Anna, given her experience and expertise with the Majorelle and Gallé furniture at the Musée de l'école de Nancy, most of which retains its original finishes.

Fig. 1. Majorelle, Louis *Bedroom Suite*, VMFA, 85.90.1-8. Gift of Sydney and Frances Lewis. Photo: Katherine Wetzel ©VMFA

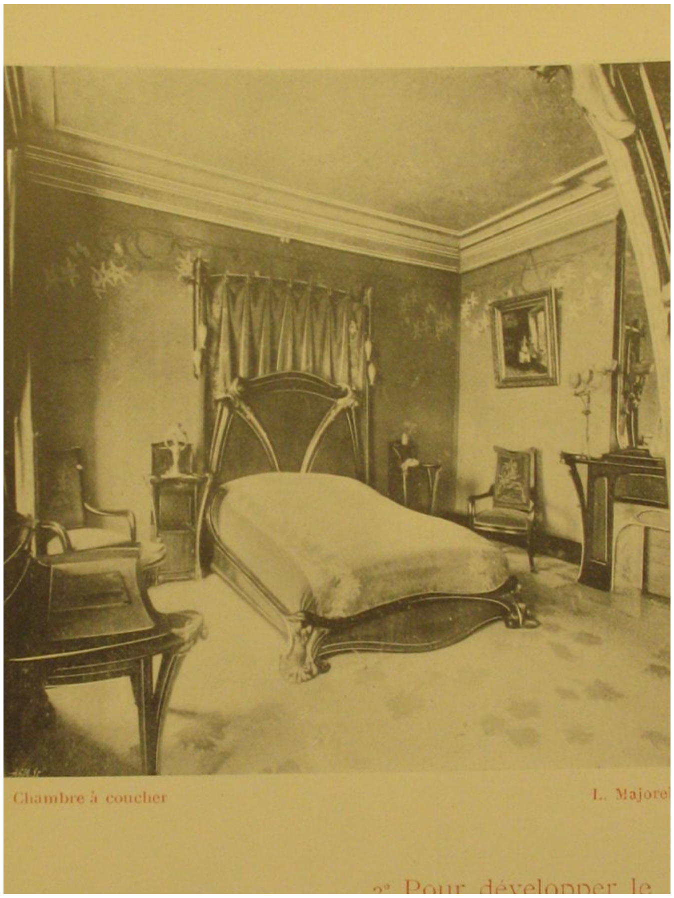

Fig. 2. *Arts et Industrie* October 1909.

Two phenomena on the bed struck us as particularly odd: the light color of the wood on the side vertical elements of the headboard and the presence of risers resulting in what we eventually started to refer to as its "club feet". The crest of the headboard and its outer frames appeared to be the same wood, but their color was quite different (fig. 3). Closer examination revealed this interesting detail (fig. 4) under the proper right bronze mounts. It appeared as if the stripping of the vertical elements was carried out without bothering to take off the bronze mounts and the boundary between light and dark wood stopped at a rough edge just beneath the mounts. This was true on both sides of the headboard, shown here with the bronze mounts removed (fig. 5).

In addition to macroscopic examination, we took several samples for microscopy from each piece of the Majorelle bedroom suite and enlisted the expertise of Dr. Susan Buck in Williamsburg, Virginia, to help us analyze the samples. Microscopy was a process Anna had not been involved in before, so this was an occasion where we could share some of our knowledge and

Fig. 3. Headboard from *Bedroom Suite* before treatment. 85.90.1-8. Gift of Sydney and Frances Lewis. Photo: Talitha Daddona ©VMFA

Fig. 4. Detail of headboard before treatment. Photo: Talitha Daddona ©VMFA

Fig. 5. Detail of headboard during treatment. Photo: Talitha Daddona ©VMFA

techniques with her. We spent one day in Susan's atelier in Williamsburg observing and learning the preparation, examination, and analysis techniques carried out on VMFA's samples. Susan provided Anna with explanations on the process, equipment, analysis, and interpretation of the data, and we left with some surprising information, as well as some additional questions to ask of the objects under study.

In the microscopy samples, we saw evidence of original and modern materials. A stain for the presence of oil confirmed its heavy use, as it could be found deep in the pores of the wood. This corresponded with Anna's experience that Majorelle and Gallé often first used linseed oil on the wood followed by a wax polishing, much like the *rempli ciré* method Anna demonstrated in her DVD. In some cases, the wood was strongly interrupted, which Susan suggested could indicate sanding prior to refinishing. In multiple samples, Susan identified the first layer above the wood as a pigmented varnish (possibly an oil resin varnish because of its quenched autofluorescence). This was followed by a pigmented shellac layer.

One sample, taken from the proper right stile, was tested to determine its pH level with m-cresol purple, and the color change to reddish purple on the surface of the wood suggests the presence of either a strong acid or a strong base, indicating that caustic stripers had been used in the refinishing process, which would further explain the bleaching out of the color of the wood. Anna was surprised to see that pigments were contained in some of the earlier coatings. She felt that the color on the crest rail was the original color of the wood, but the microscopy suggested that pigments were used to contribute at least some of this color.

In four of the five samples, there appeared to be a resinous material with a bluish autofluorescence color trapped in the wood substrate. This autofluorescence color is typical of a synthetic resin coating, but further identification would require more precise chemical analysis. It is possible that this is just a sizing, and not a finish coat, as it did not appear as a coherent layer above the wood. Some samples indicated a pigmented shellac layer as the first generation, followed by a thin plant resin varnish. The combined evidence suggests that some sort of sizing was first applied to the wood, followed by a pigmented plant resin varnish. The second generation is a pigmented shellac layer, followed by a thin plant resin varnish layer.

Samples from under diagonal mounts on the headboard showed an even less disturbed surface, although the multiple holes found for attaching the bronzes and the appearance of a continuous layer of a thin shellac coating under ultraviolet illumination indicate that the bronze mounts were removed at least for the application of a later shellac coating. These samples and ones taken from under the bronze mounts on the proper left foot did not exhibit the same disruption of the wood found on the stripped surfaces of the stiles. It would be very useful to compare microscopy samples from the other two known *au Nenuphars* beds with those taken from the Lewis Collection suite.

As a result of Anna's visit, the microscopy results, and comparison with the Musée d'Orsay's headboard, I approached our curator, Barry Shifman, with all the evidence and suggested we undertake a treatment on the headboard. The timing was perfect, as the Lewis Galleries were being deinstalled to be redesigned as part of a larger reinstallation of the entire collection in anticipation of the opening of our new wing. Our goal was to return the headboard's appearance to the state that we believe to have been the artist's intent, reversing (at least in appearance) some of the damage that had been done in the 1970s to the suite.

A view of the analogous headboard at the Musée d'Orsay (fig. 6) demonstrates how the framing elements would make more sense

Fig. 6. Majorelle, Louis *Lit Nénuphars* © Musée d'Orsay, Paris

if the VMFA headboard's side vertical elements were darkened. Both the outer top and the diagonal cross frames of darker wood show what we have come to believe was the artist's intent for those elements to act as a contrasting framework and heightening the figured veneered panels they enclose.

The first step was to determine what finish would be appropriate to use to introduce colorant. A number of solutions were considered, and my first attempt involved a product called Conserv-Art Varnish that had been suggested as a varnish that was soluble in hydrocarbons and therefore could be distinguishable and in theory removable, if needed, from the shellac coating. Conserv Art is a high-solids proprietary acryloid varnish with a low molecular weight. It not only turned out to be distinguishable, but was in fact a little too distinguishable for our desired results.

While I had no difficulty getting my Orasol dyes to mix with this varnish, the application and saturation were less than satisfying. In retrospect, perhaps I was a little too timid in the amount of dye originally incorporated (not wanting to overload a hydrocarbon solution with my Orasol suspended in alcohol and out of concern that I could easily go too dark or too red too fast). I brush applied this varnish and found that repeated applications to build up the color resulted in a gloppy, extremely glossy coating that did not come close to what I was trying to match to the crest of the bed. I should have known at this point in my career that attempts to "fix" this would really only make it worse, and I eventually decided to search for an alternative approach.

In the end I decided I had no choice but to remove the Conserv Art and at this point had the brilliant idea I would start from scratch, remove all the varnish layers (none of which seemed to be original on these vertical stiles), and perhaps try to recreate the process Majorelle or his studio would have used to finish the piece originally. I considered attempting the *rempli ciré* technique Anna had demonstrated and consulted with Anna who felt that this piece could indeed have originally been given such a treatment, following the initial application of linseed oil. Anna also suggested that the caustic stripper that had been used in the 1970s on the bed might still be reacting (since evidence of it had shown up in the microscopy) and she suggested that I neutralize what might be remaining. I used acetic acid for this purpose.

On this clean slate on I began my next experiment. When Conserv Art did not give me the desired results, I had polled other conservators for a resin that might suit my needs. Two paintings conservators recommended that I try Regalrez 1094, as they had found success in the covering power and saturation of this material for paintings. It was also soluble in hydrocarbons, which meant it would be possible to separate it from the existing shellac (on the proper right stile). I was still faced with the problem of adding the color I needed to the Regalrez, but before I got too far on options, I came across a reference to an article by Hans Piena in response to an unrelated question on the Consdist List about waxes. Piena's (2001) article in JAIC, *Regalrez in Furniture Conservation,* became the guiding light for the remainder of the treatment. It suggested that the Regalrez could be used in a wax–resin finish. I mixed Regalrez 1094 with wax, and "white spirit" (I used Stoddard's) in a 10:30:60 ratio to create a wax–resin material that would serve as an initial coat on my now-stripped proper left stile and a barrier coat to the shellac on the proper right stile. I substituted Behlen's Brown Pigmented Paste Wax for the beeswax Piena suggested because I wanted to build up the color in my wood as quickly as possible. This provided me a quite satisfactory saturated surface that I could have buffed to a sheen if I had not needed additional colorant.

Regalrez 1094 is a hydrocarbon, low-molecular-weight resin. The fact that it is soluble in aliphatic solvents makes it an excellent choice when adding a new coating is required but disturbance of an old coating is to be avoided. It remains stable after aging and, as with its use on paintings, it has excellent saturation qualities, which is exactly what I was looking for.

While the primary benefit was touted as the ability to act as a barrier between a degraded finish and a newer shellac finish, the finish I was dealing with was not degraded, but I did want to avoid adding a new shellac finish directly on top of the existing shellac finish. Initially, I wanted to avoid using shellac as my final finish coat, but I eventually was convinced that the only way to achieve a satisfactory match in color and sheen to the crest rail and diagonal frame pieces was to use shellac with an Orasol dye followed by a light wax polishing.

The next challenge was to get the two sides to match, even though the layers that would get me to the final product would be different. Figure 7 shows the Regalrez-wax application on the left, before adding any new finish. The subsequent shellac

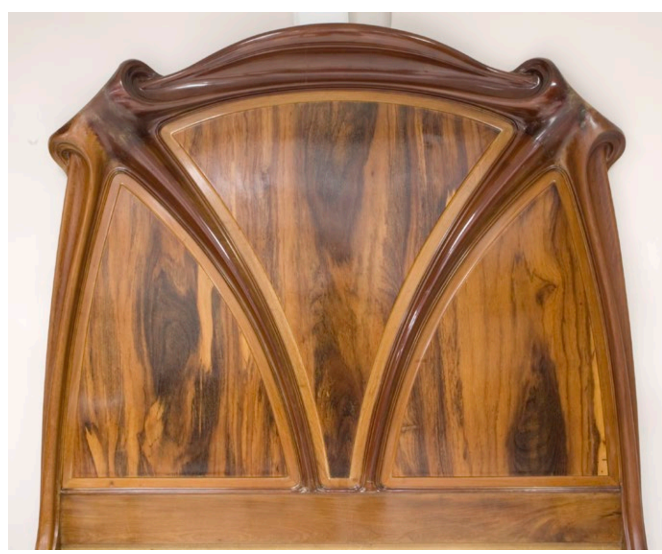

Fig. 7. Detail of headboard during treatment. Photo: Talitha Daddona ©VMFA

was padded on as I wanted to build up my coats slowly. In between, approximately every ten coats, I knocked the finish down using pumice with the shellac. For the areas adjacent to the inner panels, I actually added some dry pigments to the shellac (cadmium red and burnt umber) as they did not seem to be getting darker as fast as the other areas of the stile.

I was happy enough with the results I was achieving that I began the same process on the proper right stile, only this time I did not remove the existing finish, but applied the Regalrez–wax–resin mixture as a barrier over the existing shellac and then applied the shellac with the Orasol dye in the same manner as to the proper left stile.

Figure 8 shows final state of the headboard as reinstalled in the Lewis Galleries. With the top layers on both stiles being a build-up of shellac coats padded on, the final result does not show a discrepancy between the two stiles. It does help that they are not adjacent to each other and that the juncture of the crest and stiles is interrupted by the reattachment of the bronze mounts.

The issue of the bed's "club feet" was resolved more easily. The evidence of them being added to the bed (perhaps for the reason of lifting it to the standard height of modern beds) was quite conclusive. (1) The wood is a different species from any other wood found on the bed. (2) The photograph from 1909 does not show these feet or any other risers; instead, the bed sits directly on the floor. (3) Although two dealer's photos exist of the Musée d'Orsay's bed having exactly the same risers as our bed had when it arrived in the museum, they certainly do not

Fig. 8. Headboard after treatment. Photo: Talitha Daddona ©VMFA

appear to be sympathetic to the aesthetic of the bed and the d'Orsay has chosen to display their bed without these risers. (4) Other examples of Majorelle beds do not incorporate any risers. (5) A water-color in the VMFA collection showing another bedroom suite designed by Majorelle (dated 1909) shows no such risers. They obviously were not typically incorporated in Majorelle's lifetime. (6) Finally, we see wear on the underside of the footboard that indicates that it rested directly on the floor for some time (fig. 9). Once again, the furniture provides clues to what it has been through. Taking all these factors into account, our decision was not to include these risers when the bed was reinstalled. The feet will be retired from service, but retained in our collection for possible future interest or study.

With this project, we have learned that the color of the wood was most likely enhanced at the time of manufacture by a pigmented coating. At some subsequent point, all the surfaces were refinished and at least the stiles were subjected to a harsh chemical stripping that removed the pigmented varnish and possibly continued to react with the wood to strip it of its natural color. At a later date, it appears that the entire headboard received a coat of shellac, which shows up in examination under short-wave ultraviolet illumination.

We have no idea why someone would have done this, as it makes no sense aesthetically. Also, why it was only partially done is a mystery. If this extent of stripping was done to the side vertical element, why not also to the horizontal elements or the center diagonal elements? We may never know the answer, but we feel that the headboard now more closely resembles what Majorelle had in mind when he designed this furniture. The entire suite now looks more in keeping with the period photograph from 1909 (fig. 2, 10).

At this point I feel that I can share some valuable lessons learned during the course of this treatment.

1. I was introduced to Regalrez and had an opportunity to experiment with modifying it for application in furniture conservation. I believe that it can be successfully used in the future as a way to preserve original finishes without sacrificing aesthetics.

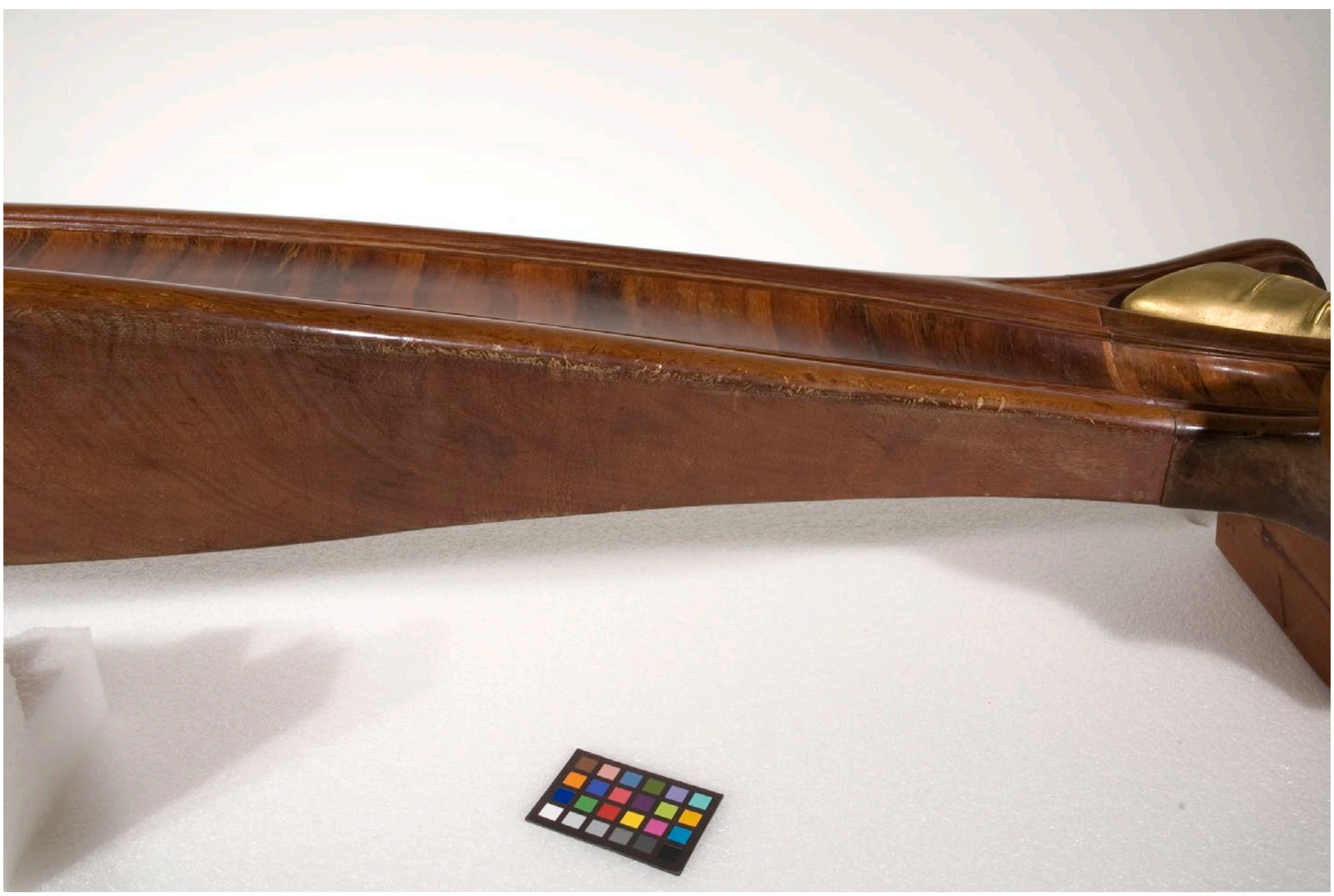

Fig. 9. Underside of footboard from *Bedroom suite*. Photo: Talitha Daddona ©VMFA

Fig. 10. *Bedroom Suite* after treatment. Photo: Travis Fullerton ©VMFA

2. An original wood ID of purpleheart now seems inaccurate. Further examination indicates that it is closest in appearance to Cuban mahogany.
3. Do not try to figure it all out yourself; use your colleagues, especially from other disciplines. They can have much to offer in approach to your projects and may introduce you to materials and techniques you may not have previously considered.
4. Do not be afraid to try something new.
5. Read the Dist List regularly. You never know when a viable solution to the problem you have been struggling with (with varnishes) will show up in an unrelated discussion (about waxes).

ACKNOWLEDGMENTS
I would like to thank Anna Ostrop for sharing her knowledge of Art Nouveau furniture making and finishes so generously with me both in Virginia, Paris, and Nancy (at a retrospective of Majorelle's work); Talitha Daddona, Conservation Assistant at VMFA, for carrying out the photography during examination and treatment of the headboard not only during Anna's visit, but also in ever changing and ever more frustrating circumstances as it moved around the museum (in three different locations) during the course of this treatment; and Susan Buck, Conservator and Paint Analyst, who both carried out microscopy on the bed and took the time for detailed explanation and demonstration of her methods and materials to Anna. I would also like to thank my colleagues—Carey Howlett, Amy Fernandez Byrne, and Scott Nolley—who directly provided encouragement, advice, and experience that still keeps me believing that the treatment of the headboard is a resounding success and the bedroom suite now looks more in keeping with the artist's intent; Brian Considine for providing me with great images and analysis of the photograph in Arts et Industry from 1909—and to Jerry Podany for directing me towards Hans Piena's article (and to Hans Piena—whom I have never met—for writing it). And last by not least, thank you to my colleagues in the Furniture and

France study programs and the French–American Partnership for allowing my participation and increasing my knowledge and our museum's ability to properly interpret our Art Nouveau furniture.

NOTE

1. Since the original presentation of this paper, the Gourdon Collection was sold at auction at Christie's in Paris in March 2011.

REFERENCE

Piena, H. 2001. Regalrez in Furniture Conservation. *JAIC* 40(1): 59–68.

SOURCES OF MATERIALS

Conserv-Art Matt Varnish
Windsor & Newton
London, England

Orasol Dye
Ciba-Geigy, Conservation Support Systems
Santa Barbara, CA

Behlen's Blue Label Paste Wax
(Brown B800-12453)
Amsterdam, NY

AUTHOR BIOGRAPHY

KATHY Z. GILLIS joined the Asian Art Museum of San Francisco as Head of Conservation in November, 2014. This paper was the result of research carried out at her previous position at the Virginia Museum of Fine Arts, where she worked for 17 years. Kathy received an MS in Conservation from the University of Delaware/Winterthur Museum in 1993 and has been actively engaged with many WAG activities since 1998.

2009 WAG SESSION

Reduction of loss in structural wooden elements through Plate Glass, carbon fiber and unusual adhesives and consolidants in the context of the Menokin Ruin

John G. Lee, Artisan Conservator, Annapolis, MD; Charles A. Phillips, AIC-PA, AIA, Conservator Architect, Winston-Salem, NC; Richard Wolbers, Conservator, Conservation Scientist, Winterthur, DE; Tim Macfarlane, Structural Engineer, DewhurstMacfarlane Partners, London, UK; Ellen Hagsten, ArchitecturalConservator, Annapolis, MD; Sarah Pope, Executive Director of The Menokin Foundation

The conservation of a significant ruin evolved into reconsidering the whole premise of conserving a ruin, as well as new approaches to all of the usual conservation issues associated with a large complex, multi-material artifact left out in the weather. The results involved testing new consolidants for wooden artifacts along with the elegant integration of carbon-fiber and glass as protheses (MOMA, eat your heart out!) for wooden structural members allowing them to be placed back in service, the development of a glass enclosure/display case/interpretive device that only provides infill (surface and structure) for the missing portions of the building envelope while utilizing ground temperature air circulated by photovoltaic powered fans to temper the interior environment; but particularly how a relatively simple system for testing structural artifacts to verify their conserved capacity to function was developed since there are no books or tables on the capacity of a partially rotted and splintered truss member with a glass prothesis. And finally building the team, which is what Conservation 2.0 is all about. While this presentation focuses on the wooden aspects of the ruin conservation, there will be a more complete discussion of the whole project in the Architectural Specialty Group session.

PS: Menokin, a National Landmark, was the 1771 Virginia home of Francis Lightfoot Lee, signer of the Declaration of Independence.

Waterlogged Wood from the USS *Monitor*: A New Direction for Research and Collaboration

Susanne Grieve, The Mariners Museum, Newport News, VA; Farideh Jalilehvand, University of Calgary, Calgary, Alberta, Canada; Robert Blanchette, Joel Jurgens, University of Minnesota, St Paul, MN; Todd Plaia, Institute of Maritime History, Kensington, MD; Dave Emerson, Bigelow Laboratory for Ocean Sciences, \West Boothbay Harbor, ME

The preservation of the waterlogged wood excavated from the USS *Monitor*, one of the first Civil War ironclads constructed, provided opportunities for conservators to work with wood chemists and microbiologists to examine the effects and retreatment of sulfur deteriorated wood as well as methods of stabilization for untreated wood. The *Monitor*, constructed in 1862, sank after a year in service while being towed during a hurricane. In collaboration between the United States Navy and the National Oceanic and Atmospheric Administration (NOAA), artifacts were excavated from the wreck site lying in 250 feet of water. While the *Monitor* is mostly constructed of iron, there are several hundred artifacts that are composed of various species of wood. Wooden components treated in 1990 are beginning to show signs of sulfur deterioration similar to the Swedish warship *Vasa*. In order to determine the most appropriate method for retreatment and to prevent deterioration from occurring in recently excavated objects, The Mariners' Museum has collaborated with related scientific fields to analyze samples from the wreck site.

New Evidence for the Use of Imported Raw Materials in 17th C Japanese Export Ware

Arlen Heginbotham – The J. Paul Getty Museum, Los Angeles, CA; Herant Khanjian – The Getty Conservation Institute, Los Angeles, CA; Michael Schilling – The Getty Conservation Institute, Los Angeles, CA

The J. Paul Getty Museum's collection includes pieces of 18th century French furniture incorporating panels of Asian lacquer. Surrounding the Asian panels, the French craftsmen imitated the lacquer surfaces with their own pigments and varnishes. In preparing catalogs of the French furniture collections, Getty Museum conservators collaborated with scientists from the Getty Conservation Institute (GCI) on an analytical research program focused on these extraordinary objects. The program has developed a methodology for sampling and analysis of the organic components of Asian lacquer and their European imitations with improved sensitivity and precision over existing techniques. The primary analytical methods used have been pyrolysis-gas chromatography-mass spectrometry (py-GC-MS) and Fourier transform infrared spectroscopy (FTIR).

The new research indicates the use of imported raw materials in 17th C Japanese export lacquerware. Normally, all Japanese lacquer is assumed to have been made using raw lacquer tapped from trees of the species *Rhus verniciflua*. The results of our research provide evidence that the Japanese lacquer on at least three objects in the Getty's collections was made using raw lacquer from *Melanorrhoea usitata*, a tree native to Thailand and Burma. A likely explanation for this unexpected finding is that the Japanese craftsmen producing lacquerware for export in the 17th century were, for reasons of economy, importing raw lacquer from Dutch trading posts in Burma and Siam. 17th century trade records of the Dutch East India Company (VOC) support this interpretation. In addition, one example of Japanese export lacquer in the collection contains dammar resin. Dammar is harvested from trees native to Indonesia, the finest quality coming from Batavia. The largest and most important Dutch trading post in Asia was in Batavia. This suggests that the Dutch were trading in dammar within Asia more than a century before its introduction to the West as an artist's material.

History and Technology: George Washington's Frame

William Adair, Gilding Conservator, Gold Leaf Studios, Washington, DC

A "Palace Frame" with engraving, given to George Washington by Louis XVI, is remarkably still in the collection of the Mount Vernon Ladies Association. This paper will briefly outline the historical significance of this genre of politically inspired gifts and describe the minimal conservation approach desired for objects of great historical significance. Time has taken its toll on the object in many ways that is typical of all frames, previous campaigns of regilding, impact damage resulting in loss of ornament, insect damage, gesso loss, and benign neglect, will be briefly outlined.

Solutions of previous (1985) and current suggested conservation (2008) intervention will be described in detail. In addition, future preservation suggestions will be outlined, as these are always essential to the long term care of gilt artifacts in all collections.

Replication of the frame is also being undertaken using 3-D scanning technology. In the future, this technology (developed by NASA) will be an essential tool for preservation of any culturally significant and unique object.

As the Carousel Turns: New Ways of Removing Aged Grease and Oil From Shelburne Museum's Dentzel Carousel

Nancie Ravenel, Shelburne Museum, Shelburne, VT; Rachel Penniman, Cleveland Museum of Art, Cleveland, OH; Laura Brill, Kress Fellow, Shelburne Museum, Shelburne, VT; Richard Wolbers, Art Conservation Department, University of Delaware, Newark, DE

Although removal of linseed oil applied as maintenance to painted animals on the Shelburne Museum's 1902 Dentzel carousel has been a regular occurrence in the conservation lab, the department had yet to address the other decorative elements of the carousel. These included painted wood panels which had been coated with linseed oil like the menagerie, and paintings on canvas which had been splattered by grease and lubricating oil from the carousel engine. Machine oil splattered on the back of canvases had worked its way through paint and varnish layers on the paintings, resulting in dark splotches in the images. Storage materials for the panels stained with oil indicated that despite being over 50 years old, the oil had not fully cross-linked. In addition to the grease and lubricating oil, the paintings were unevenly coated with an apparent yellowed spar varnish similar to what had been found on the carousel animals.

As part of a 2007 grant from the Institute of Museum and Library Services, Richard Wolbers consulted on removing the grease and machine oil from the panels. After testing solvents, solvent gels, and solvent gel poultices, Wolbers introduced Pemulen TR-2, a polymeric emulsifier to the range of cleaning agents. A water-soluble polymer, Pemulen forms stable oil-in-water emulsions without other surfactants. Product literature for Pemulen indicates that linseed oil, mineral oil, tung oil and tallow have been successfully emulsified with 0.4% or less Pemulen TR-2.

This paper described a variety of cleaning gels and emulsions prepared using Pemulen TR-2 that have been found useful after testing in removing linseed oil, grease and yellowed spar varnish from the painted surfaces of the carousel. Advantages and disadvantages of these agents were compared to aqueous and solvent gels used in the past to remove linseed oil from the painted wood elements.

In the course of preparing this presentation, the authors collaborated on its development using a wiki platform, allowing them to share documents, including technical literature from Lubrizol and MSDS sheets, treatment reports, and images over the internet on what was then a private workspace (Pemulen TR2 2009). Separate sections of the wiki provide information about Pemulen T2-2, preparing the gel, preparing the emulsion, case studies using each, a bibliography, and areas for future investigation. This workspace was opened up to the conservation community just prior to delivering the presentation. Nancie Ravenel continues to add changes in the manner in which gels and emulsions made with Pemulen TR-2 are prepared at Shelburne Museum. Thus, the wiki is a living document and continues to be used in training interns and fellows working in the lab.

In 2009, Nancie Ravenel was invited to contribute a section to a series of short articles about Pemulen TR-2 for the Western Association for Art Conservation's newsletter. The resulting article reflects what was presented at Wooden Artifact Group meeting, but also includes refinements to the technique made since that presentation was delivered (Ravenel 2010)

Further Reading

Pemulen TR2. http://pemulentr2.pbworks.com/ (accessed 9/21/2014).

Ravenel, Nancie. 2010. "Pemulen TR-2: An Emulsifying Agent with Promise." WAAC Newsletter 32 (3): 10-12.

http://cool.conservation-us.org/waac/wn/wn32/wn32-3/wn32-304.pdf (accessed 9/21/2014).

A Minimally Intrusive Upholstery Method for an Overstuffed Victorian Chair

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The object is a piece of study furniture held by the Smithsonian Institution for educational and teaching purposes, a mid-late Victorian upholstered arm chair with diamond-back tufting. As received in the Furniture Conservation Studio, the chair was primarily a wooden frame with remnants of the previous upholstery including jute webbing and tied springs. The goal of the project was to recreate the complete overstuffed upholstery original to this piece, including the diamond-tufting, making it totally removable at the same time.

The major treatment innovation introduced for this chair, produced by the furniture conservator, was the creation of a fitted Epoxy/fabric composite shell upon which the additional layers of upholstery, including trim and tacks, were to be attached. That is, the wooden frame of this piece is totally encapsulated within a "clamshell" of 2 pieces of Epoxy-stiffened canvas, to which all additional layers are stitched, glued, or otherwise adhered.

The contribution by the textile conservator consisted of making a custom-shaped "mattress" of a seat, within which the original springs are still found. Much as a mattress is completely removable upholstery for a bed frame; this custom-shaped seat functions like a mattress, and completely eliminated the rigid wire forming the front edge, previously stapled to the chair frame.

An additional challenge of this work was making the diamond-back tufting stable, and yet completely removable and fully sittable. The experience of the textile conservator, in handling fabric layers, enabled this skill to be sufficiently transferred to this new arena of minimally intrusive upholstery.

The final product of this treatment is already in progress; creation of a detailed illustrated instructional manual presenting this treatment technology for the benefit of conservation and upholstery practitioners facing similar challenges.

Globe Chair, Adhesion and Cohesion: An Interior Problem

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The second half of the twentieth century saw extensive development of materials such as plastics, fibreglass and foam for use in furniture. The Globe chair (Circ. 12-1969), also known as the Ball chair, was designed by Finnish designer Eero Aarnio and exemplifies the use of these materials. It was acquired directly from the manufacturer, Asko Furniture Manufacturing Company, by the Victoria and Albert Museum in 1969.

Now, several decades after manufacture, many of the modern materials used in the Globe chair have changed in their appearance and properties, requiring radical treatment to enable the chair to be displayed in a state representing the designer's intent for the V&A exhibition *Cold War Modern: Design 1945–70*. While the glass-fibre reinforced polyester shell had remained stable with the external gel-coat suffering only minor abrasions, the appearance within the shell had changed dramatically. The interior fabric hung limply rather than maintaining the crisp profile intended by Aarnio. The adhesive applied between the cover textile and foam under-upholstery had failed, leaving the textile unsupported, especially on the top interior of the shell where the textile hung down.

As the foam still maintains some flexibility when compressed and has not degraded into a powdery dust, we decided to retain the foam and consider a treatment that might increase its longevity. Whilst being aware that the textile would outlive the foam indefinitely, we wished to enable future re-treatment and the eventual removal of degraded foam while retaining the show cover.

The result of our treatment was a clean, crisp profile on the interior of the shell. The original materials have been kept, the shell's interior profile has been restored and the treatment executed anticipates the eventuality of the foam's degradation and replacement while retaining the original show cover textile.

The Black that Never Was: Decoding Color in the Marquetry of J. F Oeben

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The J. Paul Getty Museum's collection of French furniture includes an important mechanical table with a floral marquetry top by Jean Françcois Oeben (70.DA.84) as well as a pair of corner cupboards with marquetry panels attributed to Oeben, both produced in the middle of the 18th century. As is characteristic of the work of Oeben, many of the leaves and stems in the floral compositions are rendered in a dark, nearly black wood. In catalogs and scholarly publications about Oeben, this dark wood has variously been described as 'ebony', 'dark stained wood', or 'black wood'. As part of the systematic study associated with preparing catalogs of the French furniture collections, Getty Museum conservators collaborated with scientists from the Getty Conservation Institute (GCI) to study these and other related objects with the goal of understanding the original color of this dark wood.

Initially, microscopic wood identification determined that the dark wood in the mechanical table is holly, a naturally white wood. X-ray fluorescence spectroscopy (XRF) then demonstrated that the dark wood contains extremely high levels of iron. The presence of a yellow dye (young fustic; *rhus cotinus*) in the wood was established by high pressure liquid chromatography (HP-LC) and confirmed by UV-visible reflectance spectroscopy. A search of the 18th century literature on dye recipes for wood and textiles identified a sub category of recipes for 'bottle greens' or 'olive greens' that correlates well with the current analytical results. These recipes call for dying with yellow dye in conjunction with an iron sulfate mordant. Test batches of holly dyed in this manner yielded a range of muted greens that are probably representative of the original leaves and stems in the marquetry of Oeben. Accelerated aging of the test samples confirmed that they darken with exposure to light.