# TOOLS AND TECHNIQUES FOR DETECTING DECAY

By Guy Meilleur

In Detective Dendro's most recent case (*Arborist News*, December 2008), he wrestled with two fungal antagonists attacking the base of his client's tree, and a third that looked threatening. Dendro's inspection and assessment methods raised some persistent questions about devices deployed to detect the deep, dark decay within and upon trees. This article will survey some of the tactics used in the field, describing the advantages and limits of each. The purpose is to see which devices can answer which questions, and lead to more comprehensive diagnoses and better management of trees with decay, the decomposition of organic tissues by fungi or bacteria.

## Getting Started

Excavating weeds, mulch, and soil covering suspect areas like the trunk flare and root crown is a good place to start. Hand tools such as shovels and trowels are cheap but not fast or easy, and can damage bark. Water functions well, but makes a mess. Air tools readily clear away coarse soil, but they move dense clay very slowly unless it is moist. Carpenter ants around a tree suggest decay, and can expand cavities. Air tools will not break interior wood boundaries as they excavate cavities and allow inspection and measurement. Exposing the root crown is a diagnostic step and also a treatment, because infections can be rendered inactive when they are dried out. ANSI Z133 safety standards call for personal protective equipment, including a face shield, hard hat, ear, and eye protection.

## Noninvasive Examination

Once the outside of the tree is exposed, it can be inspected for signs and symptoms of decay. A hand lens can help identify fungi by revealing the intricate structures of fruiting bodies. Bulges can be caused by expanding internal decay. Sunken areas may be localized infections, or cankers. Aided by binoculars, the naked eye can detect stem and scaffold issues that may need aerial inspection. Blunt instruments can remove degraded tissue without breaking boundaries.

Striking the trunk with a fiberglass or rubber mallet—the "tap test"—can reveal dead bark or decay when there is a hollow sound. Electronic hammers are basic tools for measuring the speed of stress waves between impact and sensor screws. Parallel to the grain, this speed is chiefly related to wood stiffness. Perpendicular to the grain, a lower sound indicates a hollow, which may be caused by cracks or natural air pockets or decay. Echoes from brown rot are generally more audible than other decay, because the loss of cellulose creates more air pockets than the loss of lignin.

Examining decay in living trees can be done in many noninvasive ways. Open cavities can be measured by using a long probe and a measuring tape. Even small holes can be wide enough to look in, using optical tools designed for mechanics and plumbers. Both the borescope and the See Snake® consist of a tube with an eyepiece on one end and a lens on the other. With attachments, the views can be angled, magnified, and recorded with still images and video. Flexible tubes allow more complete views, but with less clarity. Even closed cavities can be viewed by drilling a small hole and inserting the device.

## Resistance Drilling

When there are strong indications of extensive internal decay but no opening, and a lack of other information to guide management, the decay can be assessed invasively using a small diameter drill bit. As the drill penetrates sound wood, there is high resistance. When decay is encountered, the resistance is less. A skilled arborist can feel this difference using a 1/8 inch diameter drill or on a cordless electric drill (Figure 1). If you save the shavings, you can send them in for a DNA assay of decay fungi, as described in the December issue of *Arborist News* (Garbelotto et al. 2008). If the drill bit gets hot the DNA can be damaged, but keeping it sharp and frequently backing it out keeps the hole clear and the bit cool. By pushing a foam earplug onto the drill bit and backing out when the wood resistance goes down, you can detect the thickness of the wood outside the cavity.

The Resistograph, a device designed to record wood strength in resistance drilling, creates less tissue loss and results in more precise results. It generates a paper printout with each test, and the data can also be analyzed by a computer program. The Sibtec digital micro-Probe's output is digital, but an optional field printer can also deliver hard copy. The Sibtec measures changes in the rate of penetration at a steady pressure. The Resistograph measures changes in torque as the probe penetrates at a steady speed.

**Figure 1: Like a doctor who sees signs of trouble and performs an examination, Chuck Lippi (left) drills to see the inner tree only when invasion is necessary. Alice Warren (right) takes images of the outside of this black olive tree (*Bucida* spp.).**

All microdrills can be deflected, giving misleading information. The Resistograph probe is stiffer and can snap instead of being deflected. Incipient decay can be detected with the higher resolution and the linear axis available in electronic versions of the microdrill.

All drilling methods need a trained eye to determine if and where the test should be done, and to reliably analyze the data, starting by visually inspecting the shavings and the wood in the flutes of the drill bit. The invasion may only be one millimeter in diameter, but in research on ash *Fraxinus* sp. trees, this size channel was more effective than the 5 mm holes made by increment borers.

Increment borers are highly portable, easily assembled but shoulder-straining tools, traditionally used by foresters to extract cylinders of wood so that growth rings can be viewed directly. The arborist obtains a close look at not only the tree's annual wood growth but also at the advancement of the pathogen.

By direct observation of discoloration in enzyme-altered tissues, incipient decay can be identified. The information gained from invasive devices may be worth the breaking of interior boundaries that occurs when the tool moves from sound to decayed wood. Aside from this lateral damage, the tool can also become twisted, creating longitudinal cracks when forced. As with all tools, keeping them clean and sharp is vital to getting reliable data. The cores can be preserved in plastic straws for later viewing. The force required to break or compress a core can also be estimated with fractometers, roughly discovering both the compressive and bending strength of the wood. Drilling and coring only provide information about the area around the hole.

## Means of Electrical Analysis

Electrical conductivity has been measured by mechanisms such as the Shigometer® and the Vitalometer. If probes are inserted into holes made by drilling or coring, the probes require no further wounding. As these instruments measure electrical resistance of the wood, they can detect discolored as well as decayed wood. The Picus Treetronic® device uses sensors to measure electrical resistance and calculate a cross-sectional map showing areas of higher moisture. The two-dimensional visual delivers more information, but its reliability depends on the placement of the sensors and other issues that an experienced operator may overcome.

Acoustic tomographic devices such as the Arbotom® and the Fakopp 2D and the Picus use sound or stress waves (Figure 2, Figure 3). These devices can offer advanced assessments, but the user must have considerable knowledge about trees, as with drills and corers, to assess tree risk.

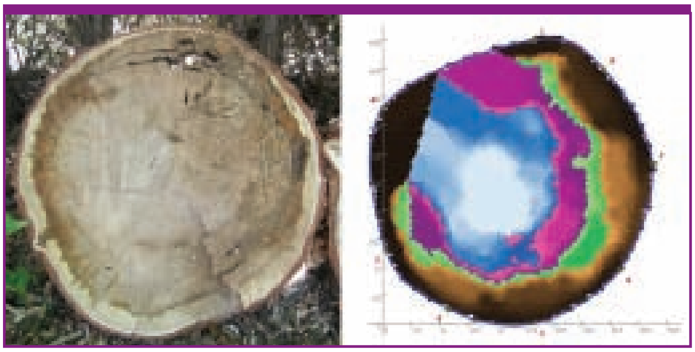

**Figure 2: By analyzing tomographs from different heights, the arborist assesses the decay column's uneven spread, and determines where the examination will go next. This device indicates the upper cross-section of a silver maple (*Acer Saccharinum*) under analysis.**

The recent history of one historic tree shows what an expensive difference a second, and third, opinion can make.

An arborist using a tomograph originally condemned the horse chestnut tree (*Aesculus hippocastanum*) that Anne Frank looked on as she wrote her famous diary while hiding during World War II. A second reading has since shown more solid wood at the base than was previously detected. This resulted in a tree pull test performed on the trunk, measuring its movement using an elastometer and an inclinometer (These utensils do not detect decay intrinsically, and are outside the scope of this article.). This new information led to the tree being preserved, and more than EUR €50,000 (USD $69,500) being spent on a support system.

## Radiography

X-ray and Gamma-Ray techniques are being tested in Japan and other parts of the world. The following technologies may have good promise for future use.

Established ground-penetrating radar technology was adapted into a Tree Radar Unit that is held to the trunk while the operator walks around it. Set-up requires about five minutes, and a peripheral scan can detect the horizontal spread of decay in about one minute. No trunk preparation is required, and nothing is inserted into the tree. As with acoustic sensing, the trunk is scanned at different heights to detect a decay column's vertical spread. The quality of the software and its use is an important consideration with tomography and radiography. The unit can also be used to detect roots, but hard clay soils can make this work difficult.

Radar users previously sent their findings off-site for analysis, but recently gained the equipment to analyze the data themselves. Gary Raffel of Dynamic Tree Systems, for example, analyzed the images in a way unimagined by the distributor's analysts. His cross-sectional dissections confirmed that incipient decay was detected by the higher moisture levels in the wood. Raffel and others use the Tree Radar Unit to detect roots, which is difficult in clay soils. Arboradix, an extension of the Arbotom stress wave tomograph, is also designed to detect roots.

## Summary

This brief look at the tactics and devices for detecting decay just scratched the surface of the field. Readers are encouraged to search the *Arboriculture & Urban Forestry* archives (auf.isa-arbor.com) and other journals for relevant scientific studies, and to contact manufacturers and practitioners for current information about product development, application, and verification. Clearly no one tool or method is superior to others for use on all trees, and we must keep our minds open to new tricks. In Sweden, insurance companies

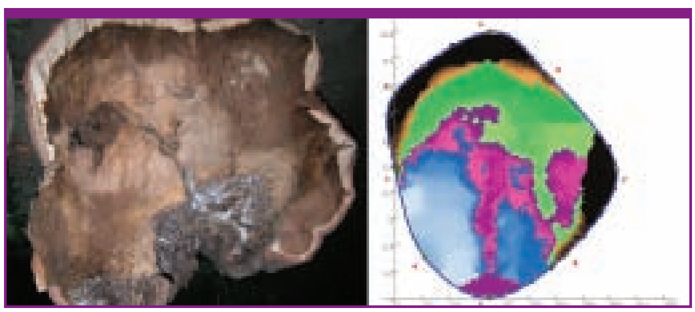

**Figure 3: The lower cross-section of a silver maple.**

***Detecting Decay (continued)***

pay to train dogs to sniff out dry rot fungus, *Serpula lacrymans*, in buildings. In France, pigs are trained to detect delicious fungi known as truffles. Perhaps someday an animal will be trained to reliably locate wood decay!

Results from any device must be interpreted to assess the decay in a tree. Without a systematic assessment of the complete tree and its site, the assessor is unable to provide a prognosis, a prediction of the tree's future condition. Strength loss formulas are improving, but they cannot assess tree stability on their own.

Overreliance on wall thickness using t/r<.3 (one inch/cm of wood for every three inches/cm of stem radius) as a criterion can lead to faulty prognosis. As with pruning, the one-third "rule" has been found to be at best a guideline, applied with other considerations. The shortcomings of different methods of tree risk assessment can be resolved by combining several methods. By gaining familiarity with a variety of techniques and their tools, and carefully analyzing the results, we can find new answers to trees' persistent questions.

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*Tomograph cross-sections courtesy of Philip van Wassenaer.*

CERTIFICATION INFORMATION

# New Year, New Opportunities . . . Jump Ahead in the New Year

**By Anne Jerutka, Certification Coordinator, Compliance & Promotions**

ISA Certification is pleased to announce the launch of Computer-Based Testing (CBT) and the arrival of the newest credential, the ISA Certified Tree Worker/Aerial Lift Specialist.

Over the past year the Certification Board, committees, and staff have been working hard with our credential holders to raise the standards of professional tree care. The decision to provide additional opportunities in 2009 was an important one and the benefits of CBT and the Aerial Lift Specialist credential are our way of providing you additional opportunities for professional development. ISA has been listening to our credential holders and has responded by developing a career path in arboriculture that is now more convenient.

## ISA Certified Tree Worker/Aerial Lift Specialist

This new credential has many exciting benefits for anyone involved in tree care. For arborists looking to obtain this credential, key benefits include becoming a more valuable asset to one's employer because of a proven knowledge in aerial lift operation. This knowledge can improve productivity, quality, and safety of the jobs at hand. Employers can make an educated decision based on the certification arborists hold and the investment they have made in their arboricultural career.

Employers will be assured that a credential holder's aerial lift knowledge has been tested by an ISA approved evaluator who has assessed the applicant's competency in the use of a lift with a focus on safety and productivity.

For those who are ISA Certified Tree Workers, ISA Certification has added another bonus to obtaining this new credential. Applicants will only be required to complete the skills portion of the Aerial Lift exam to receive this credential. The written portion of the two exams is the same. ISA will also be offering a training DVD to better help prepare for the skills exam. Please visit the ISA website for availability updates.

## Computer-Based Testing (CBT) for Certified Arborist

ISA is always looking for a way to make ISA certification more convenient. ISA has seen the opportunities holding a certification has created and would like to extend those opportunities to all arborists. Computer-based testing will reduce some of the challenges that many have expressed over the past few years. The exam will be made available in testing areas on a day that the applicant determines most convenient. Applicants will no longer have to travel 100+ miles to an exam site, wait for an upcoming exam, request time off work, or be left for several days wondering whether or not he/she has passed.

CBT allows applicants to schedule an exam within 5 business day of a test, at a designated testing area. Exams will be scheduled at a testing center provided by Pearson Vue, a leader in innovative testing sites around the world, who is dedicated to providing a secure and comfortable testing environment with immediate exam results. They are committed to catering to an arborist's busy schedule, making the process of obtaining one's credential the fastest and most rewarding experience possible. There will be an additional administration fee of $100 with the convenience of computer-based testing, but ISA is confident that the fee will be worth it. Applying arborists will never have to miss a contract or pass up a promotion again by having to wait for their certification. For many tree care specialists, it feels somewhat impossible to fit everything into a day's work, which is why ISA has made this opportunity available to all eligible candidates. Applicants will soon find the CBT option available on the Certified Arborist application along with a current listing of all available locations.

Please visit the ISA website (www.isa-arbor.com), or contact the Certification Department at 217-355-9411 for more information on computer-based testing and the new ISA Certified Tree Worker/Aerial Lift credential. AN