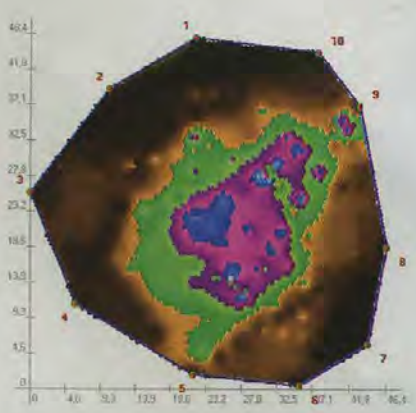
Tools for tree decay testing

by Dr. Christopher J. Luley

Accurate evaluation of wood decay in trees is a necessity for tree management in urban environments because decay is a primary reason that trees fail prematurely or are removed to prevent catastrophic damage to property or people. Decay-detecting tools are important because the extent of decay is often hidden from view, and knowledge of the amount of decay is essential when making removal decisions.

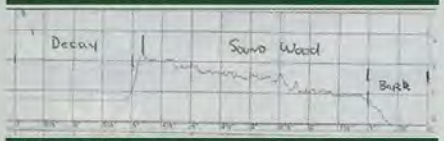
Decay is caused by fungi that enzymatically attack the cell walls and other constituents of wood. During the decay process, wood loses density and strength, as cellulose, hemicellulose and lignin are degraded. At its end point, decay results in the formation of cavities that may or may not be visible from the outside of the tree. However, even in initial decay stages there is a significant loss in wood strength that must be considered when evaluating trees for potential failure. Quantification of decay is important because trees can tolerate substantial amounts of internal decay with minimal impact on stem stability because the strength of a stem or cylinder lies in the outer shell of the wood.



A decayed trunk and output from a PiCUS scan show different levels of decay in the cross section. The nonbrown areas indicate cracks or various stages of decay.

Wood decay caused by fungi is often an internal defect. Several new tools allow identification and measurement of internal decay without destructive sampling.

An oak tree is tested for decay with a Resistograph.



A partial Resistograph chart records mechanical resistance to a 3-millimeter-diameter drill bit as it enters a tree.

Several tools have been developed in the past 10 years that can detect changes in the physical properties of wood characteristics caused by decay fungi. This article will take a brief look at only the decay-detecting tools commonly being used in arboriculture today and what their development means in the tree care industry.

Resistograph. The Resistograph is the most common advanced tool used in arboriculture to test trees for decay. This tool records resistance to a 3-millimeter-diameter drill bit on a chart — or an electronic version of the chart — that shows how far the bit has traveled into the tree. Changes in mechanical resistance recorded by the tool allow the user to identify the presence of decay and to quantify the thickness of the outer shell of wood.

The Resistograph — manufactured by IML Inc., Kennesaw, GA, www.imlusa.com — allows rapid testing of a tree for decay because a single test site can be drilled in a few minutes. The negative side of this tool is the small wound it creates internally in the tree, and only a single point can be tested at a time. This requires that the user judiciously select the drill location in order to obtain reliable results without excessive drilling.

The PiCUS system uses a specialized hammer to induce sound waves through the tree, which are then detected by a series of sensors placed around the trunk.

PiCUS. Tomography uses differences in the speed of sound waves, as they travel through nondecayed and decayed wood, to detect and map decay progression in cross sections of a tree. Testing is carried out by anchoring sensors around the circumference of a stem and inducing sound waves through the wood with a specialized electronic hammer. The sensitivity of the tool in detecting decay is partially related to the number of sensors and the software that processes the sound wave data.

The ability of tomography to capture, digitally process and display multiple test locations at once results in highly visual characterization of decay patterns in trees. This display can be captured in the field site on handheld computers or personal computing devices.

PiCUS is the common tomography system used by arborists. This system — distributed by Urban Forest Innovative Solutions, Toronto, www.ufis.ca — also

PHOTOS COURTESY OF DR. CHRISTOPHER J. LULEY; COURTESY OF JERRY BOND, URBAN FORESTRY LLC; COURTESY OF URBAN FOREST INNOVATIVE SOLUTIONS; COURTESY OF TREE RADAR INC.

has software that allows decay columns to be visualized by connecting the results of multiple test locations on a single stem. The negative side of tomography is the cost of the tool and the longer time for setup compared to point-drilling methods. Recent progress in reducing the number of sensors required for testing has allowed a reduction in cost and setup time, albeit with some reduction in sensitivity.

TRU system. One commercially available system that uses electromagnetic waves or radar to test trees for decay is the TRU system. The TRU system — manufactured by Tree Radar Inc., Silver Spring, MD, http://treeradar.com — relies on an antenna that receives and transmits radar waveforms to a field computer. In the field, scans of areas suspected of having decay are generated and received by an antenna, as it completes a 360-degree pass around the tree in constant contact with the bark.

The tool produces hundreds of diagnostic waveforms that are then analyzed by the system's signal-processing software. The output from the tree radar system is a cross-sectional depiction of decayed areas where the scan was made, along with a chart that quantifies the thickness of the wood's outer shell at each location around the stem.

The tree radar system is similar to tomography in that cost has been an apparent barrier to its general use. However, the same tool also has application as ground-penetrating radar to locate tree roots without destructive sampling.

Importance and application. As with many technologies, the advancement in decay detection and quantification afforded by these tools has posed a number of scientific and practical questions that the industry is still working to resolve. Scientifically, the ability to quan-

An output from a tree radar scan of the trunk cross section shows a stem with decay (left) and the predicted area of decay.

The TRU system uses electromagnetic waves to assess decay. In the field, an antenna is passed around the circumference of a tree, and a field computer collects data.

tify decay raises many questions concerning how much decay is tolerable in urban trees. Debate continues over what thresholds should be used when determining if trees may require removal due to decay. Many factors — such as tree species, tree health, species of decay fungus, wind load on the canopy from tree exposure, tree architecture and target (what might be struck when a tree fails) — can have a strong influence on any standardized action thresholds.

On a more practical level, use of advanced tools is still not a standard procedure in decay assessment for most arborists or tree managers. Therefore, how and when these tools are recommended and used in everyday tree risk or failure assessments requires careful consideration. Standards of assessment for decay and tree risk, or hazard evaluation, is one area that the tree care industry is currently addressing.

Dr. Christopher J. Luley is a pathologist and vice president of Urban Forestry LLC, Naples, NY. He can be reached at chris@urbanforestryllc.com.

References.

Bond, J. 2006. "Foundations of risk analysis: Use of the t/R ratio to evaluate trunk failure potential." *Arborist News.* 15(5):31-34.

Kane, B.; D. Ryan; and D.V. Bloniarz. 2001. "Comparing formulae that assess strength loss due to decay." *Journal of Arboriculture.* 27:78-87.

Luley, C.J. 2006. "Identifying wood decay and wood decay fungi in urban trees." *Arborist News.* 15(2):12-19.

Luley, C.J. 2005. "Wood decay fungi common to urban living trees in the northeast and central United States." Urban Forestry LLC. 60.