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# Friends of Stadium Woods 120822

## BACKGROUND AND HISTORY

- 2011 Two new industry standards on tree risk assessment are published. Staff notices hole in tree.
- 2/15/12 First Tree Risk Assessment submitted
- 7/11/12 Second Tree Risk Assessment submitted

## ASSIGNMENT

7/15/12 I was asked to review and report on the two previous reports. The use and purpose of my report is to inform tree management and improve tree safety and contributions.
I am limited by time, distance, a lack of knowledge about the tree and site history, and conditions noted in Appendix A.

## EXECUTIVE SUMMARY

Two reports recommended the removal of a *Quercus alba* white oak tree, citing interior decay. Based on current industry standards, pruning may have been a reasonable response, mitigating the risk of failure to a very low level.

## OBSERVATIONS and DISCUSSION

- **Sections** below are quotes from a series of four articles in *Arborist News* magazine in 2012, featuring excerpts from the International Society of Arboriculture's 2011 Best Management Practices for tree risk assessment.
- **Bold indicates points of special concern.**

## Report #1, 2/15/12

The first report assessed good stability in the branch structure of Tree #131, saying that "Stem defects occurring in the zone between four feet above ground and the first live branch are most critical. This area of the stem is a major stress point during periods of high winds." Industry literature cites branch failure and root failure as more common than stem failure. Rarely do oak stems break in the middle. No explanation or reference was given to support this opinion. No inspection of this portion of the tree was recorded. In systematic fashion, the report proceeded from the crown to the trunk to the base:

"A burl surrounds the cavity on the left and right side. These burls or abnormal tissue growths do not lend structural integrity to the base of the tree…". There is no support or reference for this opinion, nor any mention of decay in the burl. Without decay, burls are typically stronger than normal wood, due to thickened cell walls, compacted xylem, curved grain, and other anatomical features. Dr. Brian Kane, a former researcher at Virginia Tech, has measured "woundwood" that grows around cavities as at least 140% the strength of normal wood (2008). "Abnormal" tissue in this burl was probably supernormally strong, but it was treated as if it was not there. The burl is near ground level and is still available to examine for strength and integrity.

The report accurately notes that "75% of the circumference has excellent root flare with no visible sign of decay. .. the healthy side of the tree where the root flare is most prominent is opposite the lean (and the cavity)." Good support on the tension side of a tree's lean is an important mitigating feature. Report #1 goes on to observe a "large seam on the opposite right side of the cavity beginning at 18" and extending 10' (Fig. 4). The seam contributes to the overall defect of the tree". Pictures indicate that the seam is reaction wood, a type of woundwood which, even more typically than burls, can be stronger than normal wood.

**Seams** can indicate cracks and decay within the trunks. Sounding with a hammer or probing with a wire or rod or drill can detect and measure these problems, but no such inspection was noted. Where the seam started and finished, and where it is thick or thin, can also be useful information, if it is observed. A wood coring instrument, familiar to foresters, could have been used to verify the location of cracks or decay, and the tissue quality in the seam and in the burl. A few core samples might have shown the assessors real strength in that wood, enough to change the calculations, and the conclusions.

The focus went back to the wood thickness outside the cavity, using a discredited engineering formula with artificially high parameters such as **"**the minimum thickness of sound wood must be greater than 15.5" for the tree not to be considered a severe risk." The minimum sound wood needed to remain outside the critical rating was 8.46", but the unexamined seam "clearly tips the defect into the critical rating.". This seam could have been revealed as a strengthening feature, but it was apparently judged by appearance alone. The use of the term "defect" for this structure was not defined or explained.

BASIC BIOLOGY

The taproot is the first thing to grow out of a germinating acorn. It remains vital to the oak until the buttress roots extend outward to support the maturing tree. The taproot is typically shed, and decays. As the tree ages, decay often moves upward into the heartwood in the center of the trunk. Heartwood contains waste products deposited by the tree over time. As with the taproot, the loss of heartwood is natural shedding. Like the crumbling outer bark or the falling leaves in autumn, the tree no longer needs these parts.

Shedding old leaves does not compromise the tree's health. Shedding old bark does not compromise the tree's protection. Shedding the taproot and heartwood does not compromise the tree's stability. Mature trees are supported by their buttress roots. As a test, balance a spoon on a paper napkin ring. Then a fork. You might even try a knife. Supported by thin shells of sound wood, many hollow oaks stand for centuries.

Heartwood is heavier and more rigid than outer wood, so its loss increases the tree's flexibility. When the tree can flex during storms, more energy is transmitted from the tree into the earth. This movement decreases the risk of root failure, which is much less common than branch failure. The least common way that trees are lost, and potentially do harm, is stem failure.

RATING RISK

The total risk rating was reached by adding numbers from previous ratings. This format was presented in a 1994 manual. It was meant to be used on populations of trees, not individual specimens. As described in the International Society of Arboriculture's 2011 BMP manual, ratings are not cardinal numbers, but ordinal numbers,. Adding or multiplying ordinal numbers does not yield a mathematically valid result.

This company has contracted to remove trees for the university, which puts an unavoidable bias on their report. However, it is systematic, demonstrating some objectivity and competence. Simple inspection of perceived weak points or "defects" was lacking. The methods of assessment and analysis were biased toward removal, likely leading to an unjustifiable recommendation.

## Report #2, 7/11/12,

Report #1 stated that their assessment used the same methods as Company #2, so calling in Company #2 for a second opinion was unlikely to yield a different opinion. However, there are few companies that are current with industry practice on tree risk assessment. Report #2 included less detailed observations, but more detailed calculations. It's not clear that this is a basic Level #2, or an advanced Level #3 assessment. Industry standards call for the level and detail of tree risk assessment to be specified.

This report has a more narrow focus than Report #1, on interior decay in a small section of the trunk. Company #2 arborists had a choice of multiple evaluation tools and techniques to evaluate the whole tree or the part with the greatest likelihood of failure. It was called a tree structure evaluation, but it was primarily a trunk structure evaluation. It did not include inspection of the crown and roots, or any attempt to diagnose the cause of the decay. It merely measured, and analyzed the numbers. **Emphasis on loss of heartwood** may have discouraged a more comprehensive inspection.

**The Basic Assessment Process includes these steps*:*

*3. Revie*wing the site history and conditions, and species failure profile* * **Without diagnosis, there can be no prognosis of residual risk** after any mitigation treatment, short of removal.

*4. *Assess load and adaptive growth*.* The report noted the vitality in the crown, but did not mention the mitigating effect of the nearby trees, which lessens load and risk. It also **failed to assess the adaptive growth i**n the burl or the seam.

*8. *If necessary, recommending an advanced assessment*.* Sampling and analyzing tissue from the burl could have revealed its strength, but neither this nor root inspection nor aerial inspection was suggested or done.

Tree #131 is described as an Edge Tree, which means it is newly and significantly exposed. It's not clear that there was recent clearing around this tree that significantly exposed it to failure.

"Crown size Large for trunk size, Architecture Balanced,…" These qualities provide reasonable options for reducing and removing branches, which is standard practice to reduce load and mitigate risk. Pruning was dismissed in a boilerplate section in the summary.

"Dead branches Percent 5 % Max size 4 in. Risk rating Moderate…, Vitality Fair" Dead branches that few and that small generally cause no more than a low risk, and indicate a moderate to high level of vitality. These ratings seem higher than observations indicate.

The Tree Structure Evaluation Field Form notes a "Cavity opening Width 84 in.". The first report measured it at 24", and the images agree. Only with the structural integrity of 60 circumferential inches of burl wood dismissed, as in Report #1, could this entry be considered accurate. But abnormal is not the same as absent. Any woodworker can testify to the strength in burl wood. Objects carved or turned from burls are less likely to crack than those made from normal wood. Subtracting wood that appears abnormal, but may be supernormal, does not seem reasonable.

If the burl was not subtracted, the opening would be calculated at 11% of circumference, not 41%. If the burl was assessed by coring or other means, the strength gain from adaptive growth could have been calculated. Burls decay in time, as everything does, but burls can stay solid for centuries, even millennia in some trees. Using this method of evaluation dismisses burls instead of inspecting them, severely skewing the analysis and conclusions toward removal.

Further subtraction of supporting wood tissue took place in the drilling tests. Data was adjusted downward due to the thickness of bark, which is dismissed as non-supportive. **Bark thickness was entered as 1.5"**, which would be unusually high for the species, if it were accurate. This error is probably not due not to human error in field measurements. Another trunk structure evaluation performed by this company used a field form with 2.5" entered as the thickness of *Quercus stellata* post oak bark, when in fact the bark was under 1" thick. Both numbers end with .5, not .4 or .7, indicate they were probably generated by a computer, and not corrected in the field.

**Drilling at ground level invites the spread of decay.** No mention is made of guarding against infection before, during, or after the wounding., although decay fungus can move through barriers in 2 months' time, according to *Diagnosis and Prognosis of Wood Decay in Urban*

*Trees:* "Tree risk assessors should also consider that drilling into decay can breach CODIT walls and allow compartmentalized decay to spread."

## Both reports on Tree #131

Burled tissue was dismissed and default entries applied, instead of making physical measurements. Both called for the same ~15" of sound wood for the tree to escape the Critical category. According to the table, a tree standing on 54" of sound wood is a Moderate Risk to fail. This thresholds seems unreasonably high, even under extreme loading. But contrary to industry standards, load is not considered in either evaluation. Neither are mitigating conditions that lessen risk, including a relatively undisturbed rootzone, sharing of load by adjacent trees, and adaptive growth in the seam and elsewhere. Formed in response to past loading, adaptive growth reinforces the tree against future loading.

Aggravating conditions are listed, more red flags to watch out for, but the judgment had been made: "Failure imminent; personal injury and/or property damage inevitable." Given the infrequent use of the area, lack of property underneath, and the strength of oak wood, this inevitability is far from certain. There were many ways to prune or support the tree to avoid failure toward the climbing wall or any other target, but both company's analyses found the risk "unacceptable", and that was that.

There is no description of how the findings are analyzed, just a paragraph of boilerplate text on the dangers in trees**.** Industry standards mandate that all recommendations should include a statement addressing residual risk following mitigation. The boilerplate did not include the increase in the risk from the increase in the exposure of neighboring trees caused by the removal. Tree #131 had a powerful capacity to absorb loading from storms, and transmit it to the earth. Now the surrounding trees will be forced to deal with additional loading. No mention was made of post-removal tree or site management, to mitigate this increased risk.

Arborists have heard for decades about the "Demon of Decay", much more than strengths in trees. To the lay reader, the lack of deliberation before the invasiveness and expense of drilling into the tree might seem unusual. Arborists can also forget that interior decay in oak trees is common; a natural result of heartwood being shed. The finality of the recommendation seems to leave little to talk about, yet at the very end of the report, client-contractor discussions are urged. If the written report is incomplete, that should be disclosed at the beginning, with any other limitations.

This criterion for Root Thickness =>15% of dbh comes from **formulas for engineering inamimate objects**, like pipes. However, "Trees are not pipes", according to a BMP coauthor. **In order to increase reliability and consistency of application, it is important to provide clear explanations of the terminology and significance of the ratings defined for likelihood, consequences, and risk.**

The formula makes many **assumptions that may differ from actual trees…carry some inherent error, which could be cumulative in the calculations*.* In fact, the numbers in these assumptions always differ from actual trees. No tree has the uniform material strength and shape assumed, and all *Trees can adapt to weaknesses and stand for many decades if sufficient structural compensation occurs…Tree risk ***assessors should look for and assess the significance of response growth*** *when evaluating likelihood of failure*.* This was not done.

**No adjustment is made for the strength of Quercus alba**.

Bark is typically deducted in these calculations due to its relative lack of strength. **Bark thickness is reported as 1.5**", which would indicate extremely thick bark plates for a white oak. If this is a default setting, it should have been corrected in the field. This incorrect assumption led to a significant math error, and skewed the analysis toward removal.

"**Risk Assessment:** The likelihood of failure due to stem or root failure is imminent." **Imminent: failure has started or is most likely to occur in the near future, even if there is no significant wind or increased load. This is a rare occurrence for a risk assessor to encounter, and may require immediate action to protect people from harm.** Based on industry standards and physical evidence, it is difficult to imagine any reasonable and prudent person near the tree saying failure is imminent.

Judgments based on mechanical and statistical evidence relied on many assumptions. Substantial error can occur during measurement, and further error in analysis. The BMP makes it clear that the ordinal numbers used in ranking should not be factored in evaluating risk, because adding or multiplying them leads to error. Whether this also refers to applying all of the uncertain numbers used in TSE thresholds is not guaranteed, but more caution in applying levels of certainty in calculations does seem advisable.

**Severe consequences are those that could involve serious personal injury or death, damage to high-value property, or disruption of important activities**.* Rating consequences as "Severe" seems high, due to low occupancy of the target area. **The loss of the asset in the tree** itself was very likely be the highest consequence of failure, but BMP this **was not mentioned**.

<u>SUMMARY</u>

In summary, apparent weaknesses observed in the planning, operation, and analysis of this tree risk assessment include:

PLANNING

- **Tree risk assessors did not communicate the benefits of trees**
- **Assignment narrowed, with a bias to interior decay and whole tree failure**
- **Formulas based on engineering inanimate objects**
- **Occupancy rates, list of tree conditions, not mentioned**
- **No diagnosis, no prognosis of residual risk, no mitigation except removal**
- **Potential load on the tree after pruning not assessed**

OPERATIONS

- **Root collar not examined**
- **Most invasive method was used first**
- **Soil on drill holes, sanitation questions**

- **Bark thickness reported as 1.5, actually ~ .5”**
- **Assessors did not look for and assess the significance of response growth**
- **No adjustment is made for the wood strength in Quercus alba**

ANALYSIS

- **Extra stability from wide base not factored**
- **Consequences of Failure omitted until the conclusion**
- **Pruning rejected as ineffective without cause**
- **Recommendation was volunteered, not assigned**
- **Low risk tolerance not disclaimed**

The focus on the trunk is difficult to understand. Trunk failure is unlikely, so it should be considered last, not first. This eye-level focus may derive from forestry’s focus on trunk diameter at breast height, which forester need to know to harvest wood products. Arborists practice arboriculture, not forestry, and need to examine the entire living tree. There is no logical or scientific reason for assessment to start, or stay, in a short section of the trunk.

## POSTMORTEM RISK ASSESSMENT OF TREE #131

The area was highly unlikely to be occupied during the kind of extreme weather event that it would take to topple this tree. We do not know exactly how much risk there was, but we do know:

1. It stood up to everything thrown at it so far.
2. The risk of the adjacent trees sustaining limb damage or uprooting or even failing at the stem are greater with this tree removed.
3. The uppermost and outermost foliage makes stems whip, pulling the tree off center, and
4. It would have posed less risk, if the tree had been pruned to lessen:
    - ✓ Lean,
    - ✓ Loading, by wind and rain and gravity on long branches, and
    - ✓ Lever arm, at the ends of the whips.

## APPROPRIATE RESPONSE PROCESS

When features on or in a tree cause a concern, they can be approached from the tree’s perspective, over time. This approach is similar to the many experimental “trials of strength” between pathogen and host tissue conducted in blocks of wood. Arborists do the same on living trees, incorporating arboricultural treatments such as root invigoration, proper fertilisation, pruning, mulching, pest management, supplemental support, management of adjacent plants, and irrigation.

Documenting signs of both strength and weakness delivers a balanced view of the tree’s condition over time. Adaptive growth, like callus and woundwood, is documented with images and measurements, as the tree constructively responds to stressors. The length, height and width of dead, infected and infested areas are also recorded, and the resulting host/pathogen ratio is factored into future decisions. The weaknesses in Tree #131 were considered, but its strengths were not. Since it is the tree’s fate at stake, it seems only fair to give it a say in the matter.

## RISK ANALYSIS AND RECOMMENDATIONS

"*Acceptable risk is the degree of risk that is within the owner, manager, or controlling authority's tolerance, or that is within a defined threshold.*" Both reports skipped the first option, instead defining this threshold within those companies, based on undisclosed assumptions, imperfect machines, and inherently flawed formulas. Instead of gathering raw physical data by closely inspecting the tree, both chose a **hands-off method**. Their format then imposed a series of artificial thresholds on the decision, instead of letting the owner decide.

Company #2 has skilled employees who could do this work, but they also have deep pockets. One division, with 11 of its 70 total branches, has $1.7 million in assets, and $670,000 in the bank, according to an internet source. Any way you measure it, this private company has a lot to lose. For them, prudence dictates a conservative approach to matters of liability and risk. Nothing in the report indicates that VT was advised of the low risk tolerance that Company #2's methods and recommendations would be based on. Other practitioners who are exposed to these methods and thresholds, in print and presentations, need to at least consider this low risk tolerance. Better yet they could follow the BMP, and let the client decide.

**Tree risk assessors should resist the ultimate security of risk elimination based on tree removal and consider possibilities for retaining trees when practicable…Dead, dying and weakly attached branches can be pruned…Wind resistance can be reduced with reduction pruning…Over-mature trees in natural settings may reconfigure as they age and deteriorate (similar to a taproot withering and lateral roots dominating-ed.), a process sometimes called 'natural retrenchment. They may continue to grow trunk diameter while branches die and fail—reducing overall height of the tree and increasing stability. Where tree risk is a concern, tree risk assessors can imitate this process by recommending crown reduction*.* The **report rejected pruning as ineffective** at lowering risk to their level of tolerance, but **gave no explanation** about what type or degree of pruning was considered, or how the judgment to reject pruning and other arboricultural treatments was made.

**In considering risk and mitigation measures, **tree risk assessors should communicate the benefits of trees** as well as the consequences of losing them…The following items should be included in a detailed written report or other documentation:…**occupancy rates**…Site factors that were considered (history of failure, storm patterns)…**a list of tree conditions**, structural defects, and response growth that were observed…may be included*.*, but they were not.

The report **fails to mention any mitigating factors**, although **Guidelines should be considered a starting point and should be modified as needed so that they are appropriate for the tree and site. While 'likelihood of failure' guidelines are presented for individual defects and in several cases, multiple defects; it is essential to consider all of the aggravating factors as well as any mitigating factors such as adaptive growth in the tree.** Recommendations cite the potential targets and the math (including the miscalculations of average soundwood etc.), but mention very little about any **other factors about the site** or the tree.

CONCLUSION

The study of tree biomechanics involves biological responses. The apparent errors and omissions in this report seem to stem from an overly mechanical approach to a biomechanical problem. The lack of precautions about wounding, overemphasis on a theoretical danger in the natural process of shedding heartwood, and the intentional mistakes repeated while erring on the side of safety with the numbers; all combine to skew the results toward removal. Their extremely low risk tolerance may also explain why Company #2 refers litigious and liability-prone projects to private consultants. A more balanced approach would pay more attention to the tree, based on guidance in the BMP.

The primary author of the quoted BMP material was employed by Company #2, but the BMP approach has yet to be accepted by all of the branches. The company deserves recognition for performing many services well, and this report cannot be judged in its entirety without knowing what was discussed between client and contractor. But in the context of the BMP, the structure of these evaluations has significant defects leading to critical risk of failure to deliver accurate assessments and reasonable recommendations. If tolerance of professional risk is low, removal and replacement of this evaluation format should be considered. If this and other mitigation put into practice, positive change is imminent.

In interdepartmental mail with the director of facilities that was not intended for public consumption, but made at a public university, a professor commented:

"…their method of assessment and reporting is not consistent with current best practices of tree structure evaluation and risk assessment. Within the last year, a national standard for tree structure evaluation was adopted by the American National Standards Institute (http://www.tcia.org/business/business-resources/ansi-a300/part-9). This is the voluntary consensus standard based on a nationwide panel of subject-matter experts. Along with this standard, the International Society of Arboriculture has published a best management practice for tree risk assessment.

These are the yardsticks against which any organization will be measured in determining if they are prudent and reasonable in their approach to assessing and managing tree risk. Keep in mind that I was not involved in writing the scope of work for these arborists, so they may have given what they were asked to give. If the arborists that evaluated this tree had used methods of assessment and reporting more consistent with these standards, then perhaps their recommendations wouldn't be so heavily scrutinized."

The VT professor's response to these reports might also apply anywhere else that a similar report was made. Had these reports been available earlier, staff could have

1. found the measurement and analysis problems noted above,
2. gathered additional data on the burl and the seam,
3. consulted the standards, and
4. saved the university the expense, loss, and ill will caused by the removal of the tree.

This concludes my report. I can be available to clarify any portions of it.

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APPENDIX: ROOT COLLAR EXAMINATION SPECIFICATIONS (for landscape trees)

Inspecting the trunk flare and above ground roots is a mandatory requirement for all tree risk assessors, per ANSI A300 Part 9 93.4.2.2.1. Mulch should NOT be touching the trunk. "Piling mulch against the trunk or stems of plants can stress stem tissues and may lead to the development of insect and disease problems or stem girdling roots." from http://treesaregood.org/treecare/resources/ProperMulching.pdf

General: Refer to ANSI Z133.1 and A300, Parts 1, 2, 8, and 9, and the ISA BMPs

Objectives: Improve stability and health. Reduce structure and loading. Improve harvesting of sunlight, and appearance.

1. **Root Crown Examination (RCX)**: Rake the fresh mulch away from the trunk 2'.
2. Slide the bottom of a shovel flat along the trunk and smoothly into the ground. Stop when resistance is met. Push the handle of the shovel, to separate soil and older mulch from trunk.
3. Empty the shovel into a container. Continue excavation until trunk flare is exposed, using a trowel or compressed air or water to achieve >6" clearance between trunk tissue and soil or mulch.

4. Redirect or prune roots that are girdling or circling trunk tissue.  Leave roots that are grafted, or doing more good than harm.
5. **Decay assessment by sounding and probing**:  Tap the wood around the openings in the sinuses with a blunt tool.
6. Where the sounds are hollow, gradually remove dead tissue.  Stop when living or hard tissue is encountered.
7. Finish tracing dead, loose material with a carving tool such as a chisel.