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UAA
UTILITY ARBORIST ASSOCIATION

Considerations When Deploying Crew Technology

By Chris Kelly, Co-founder and CEO, Clearion

FOCUS ON TECHNOLOGY

It's amazing how quickly the digital landscape has changed for utility vegetation management (UVM) in just a few years.

While work management software has been widely used in the utility industry for more than a decade, until recently, most VM crews still received work instructions and reported work progress on paper.

As crew-level software moves into the mainstream, it's been unlocking efficiencies for contractors and utilities. Not only are crews receiving clear information, but utilities are getting better information back from crews faster than ever. Utilities are using crew technology to elevate high-priority tasks and help crews find the right work location—even if it's miles off a dirt road and down a remote, mountainous transmission right-of-way (ROW). Importantly, back-end processes are being streamlined with reduced times for audit and inspection which, in turn, serve to get invoices processed and paid faster. However, the shift away from paper comes with its own set of challenges including some complex considerations.

Contractor-Owned Devices vs. Utility-Owned Hardware

A few years ago, as an early adopter of crew technology, a large U.S. transmission operator opted to provide utility-owned devices to their contractor crews in order to meet internal cybersecurity requirements and foster usage through turnkey device support. Today, however, many utilities are pursuing the bring-your-own-device (BYOD) strategy (i.e., smartphones, tablets, and laptops not owned by the utility) with their contractors as the benefits may outweigh the challenges.

The benefits of BYOD:

- Reduced direct costs for utilities as the technology investment is absorbed by the VM contractors
- Better user experience as crews utilize the same devices for their work instructions as they do for other work- related functions (e.g., safety applications, time sheets, expense management, training) without the need to carry multiple devices
- Uniform end-user support and greater control for the contractor (where contractors don't need to assist employees with the use of a second hardware device, which can be the case with utility-owned mobile devices)

The challenges with BYOD:

- Blurred employee privacy issues when company-owned devices are used to conduct personal business (e.g., family pictures, private phone calls)
- Heightened security concerns as the responsibility for managing the hardware shifts to the VM contractors
- Support for end-user applications on

contractor-owned devices can create a learning curve for contractor IT team

Just as utility VM contractors have been expected to expand their core competencies over time as the techniques and approaches to UVM have matured, the digital revolution in the UVM world is requiring these same contractors to become experts in deploying, managing, and securing hardware that carries mission-critical and sensitive information.

Security Risks

The electric utility industry takes its responsibility to maintain a strong electric grid very seriously. As such, with the distributed workforce of contractor crews comes the challenge of remote device monitoring to address viruses, hacking, and other cybersecurity issues. Data loss through security breaches can happen as the result of unauthorized users gaining access to the contractor or utility network to view, copy, or transmit data. To minimize this threat, companies are employing sophisticated data management tactics, including device encryption and remote wipe capabilities to erase data on devices that have been lost or stolen so the data won't be compromised.

Other options to minimize security risks include third-party management and/or reducing access to sensitive data.

Throughout 2020, a large Midwest utility is partnering with one of the leading UVM contractors to deploy software to hundreds of users—from crews to general foremen—by leveraging an enterprise mobile device management (MDM) system for remote device management, application security, and control. A proven third-party solution can provide the expertise needed without the investment of in-house personnel.

A large, electric distribution company in the southeast U.S. enabled its community of UVM contractors to download an app from the public Apple and Google app stores onto smartphones owned by the contractors or the employees themselves. The utility provided the work locations on the map along with non-sensitive background data, thereby eliminating security risks of putting utility asset data on the devices.

User and Identity Management

UVM employs a dynamic workforce with high turnover, which presents unique challenges in the form of user management (i.e., access and control), including the ability to revoke access immediately when needed.

Today's technology often provides a simple user management interface that the utility and its software vendor jointly manage—and with different roles—role-based technology that automatically adjusts based on position is critical. For ease of use, crew members, crew leaders, general foremen, and supervisors install the same application; however, it automatically changes appearance and functionality based on the role of the user.

Three Main Uses of Crew Technology

- **Pre-planned work**
  Contractor crews receive work instructions for specific locations within a territory (e.g., circuit, feeder, geography) that the utility or contract arborist has identified during a planning patrol. These work locations can be individual tree trims, removals, or other discrete work. The contractor crews need to navigate to the work locations, view instructions (including any restrictions), mark the work complete, and note any exceptions.

- **Work-to-standard**
  Contractor crews are instructed to meet clearance specifications. Via digital maps, crews can view work locations/spans, utility assets, restricted areas, customer notes, access routes, and other information to improve safety, efficiency, and transparency of the work. Crews can mark each span complete providing real-time progress updates to the utility and their supervision. For out-of-scope or add-on work, crews can create new work locations, capture the attributes of the work, and share before-and-after photos.

- **Reactive work**
  Contractor crews receive tickets for storm events, customer trim requests, and priority work. These work locations are placed on a map and annotated with relevant information. The app allows the crew to view a list of open tickets, sort by due date or priority, and navigate to the work location. When the work is marked complete, the status (along with any notes) automatically flows back to the UVM department and can also pass back to the call center software (or another system of origin).

Training and Adoption

It comes as no surprise that most crew members have smartphones. Learning how to navigate apps has become second nature. Think Facebook, Venmo, Waze, YouTube, and more. With time, the need to train users has taken a backseat. Today's focus is on creating a user experience that is simple and intuitive—and one that makes work easier and burden-free. Crew-facing software is no exception; it is focused solely on the task of enabling crews to find and complete assigned work. As the software is constantly evolving with new features, bug fixes, and ongoing changes to the visual and logical parts of the application, pushing updates should be easy and seamless to the end-user.

You're Not Alone

Utilities and contractors alike are facing important challenges to ensure the successful adoption of crew technology in an era of heightened security risk. At Clearion, we encourage all interested companies to consult with their preferred technology partner to evaluate the benefits and drawbacks of different approaches and identify the optimal solution for their specific environments. We're all in this together.

President's Message

By Eric Brown

The significant value that robust utility vegetation management (UVM) adds to an electric utility, community, and its stakeholders has been well documented in the industry. Many UVM programs across North America operate from a highly traditional perspective. Forward-thinking operational excellence and the continuous improvement value opportunity are often not entirely realized. To extract the maximum performance improvement value opportunity, the application of progressive superior practice VM strategies, coupled with technology and collaborative teamwork, must be applied. When successfully executed, these complementary forward-looking synergies have the potential to revolutionize the UVM industry as we know it today.

Highly successful UVM organizations of the future will incorporate and integrate both technology and business strategies into their management, operations, and work culture of their VM organizations. Succeeding tomorrow will require utilities, consultants, and contractors to strike a fine balance among achieving reasonable financial results despite potential revenue decreases; meeting higher system reliability metrics, such as public, contractor, and employee safety and other regulatory requirements; and meeting increased demands for superior customer service.

Select few industry leading UVM programs are beginning to achieve this important balance by applying strategic approaches and incorporating technology to optimize efficiencies and manage resource deficits (qualified, skilled personnel primarily). Implementation and execution of these progressive approaches goes beyond the application of just a new trendy UVM business model to a fundamentally new way of managing the twenty-first-century UVM program demands and challenges. As stated previously, UVM programs are traditionally very attached to the historical ingrained UVM philosophy.

Operational efficiencies can be hidden by traditional operational work practices and cannot be fully realized until an organization can break out of its traditional paradigm, and challenge the status quo and each other to strive for continuous improvement and operational excellence. UVM managers and their strategic partners must openly commit to each other to innovate, develop, implement, and drive continuous improvement so that the highest value can be extracted.

Ask yourself: what are the hidden costs and performance improvements that could be derived from your VM program *if* you embraced integrated proven, progressive technology into your UVM program? So, what are *integrated proven, progressive technologies*? Examples include:

Utilities
- Remote Sensing Technology (LiDAR, Ortho, Oblique, Hyperspectral imagery)
- Augmented Intelligence (AI)
- Remote Weather Stations
- Unmanned Aerial Vehicles (UAVs)
- Early Wildfire Detection Cameras
- Smart Reclosers
- Real-Time (LiDAR/imagery/and advanced corona cameras) Pilots "future state"

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- Sena Bluetooth Hardhat Communication Devices
- Global Positioning Systems (GPS)
- Mobile Devices (Smartphones/Satellite Phones)

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- Laser Range Finders
- Global Positioning Systems (GPS)
- UAVs
- Mobile Devices (Tablets, Smartphones)
- Mobile Software (Data Collection)
- Remote Sensing Technology
- Smart Applications

A Vision for Tomorrow

A new age of UVM has started emerging in the industry. It's clear that traditional UVM work practices and methodologies are ineffective and produce mediocre levels of performance. As mergers and acquisitions, deregulation, financial earnings, and regulatory pressures all continue within the industry, the use of these progressive strategies within VM programs will ensure the long-term viability. Senior leaders, customers, and general industry "standards of care" have raised the level of performance expectations. UVM organizations must embrace progressive technology advancements. The UVM industry must overcome fear of the unknown, embrace change, and realize that breaking out of its comfort zone means that it's leading your organization/UVM teams toward higher performance. The vision for tomorrow is a fundamental paradigm shift from a limiting traditional perspective to a strategic and superior practice perspective. This will result in revolutionizing the UVM industry. Never be satisfied with the status quo. Lean on your peers and industry organizations like the UAA to support your transformation and journey. As you begin your evolution toward operational excellence, remember a quote from Steve Jobs: *"Innovation distinguishes between a leader and a follower."*

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Executive Director Comments

By Phil Charlton

The UAA staff and board have taken a little time to review 2019. It was a great year!

We entered the new year with more than 5,000 members. Hundreds of our members committed their time to making the UAA and the utility vegetation management (UVM) industry a better place, and their efforts paid off.

Here are just a few of the highlights:

Let us start with UAA educational and networking opportunities. This has been an emphasis of UAA for many years. In 2019, we saw some exciting results.

- Attendance at the Trees & Utilities conference grew more than 50 percent compared to 2018, with 850 participants.
- Nearly 1,100 attended regional events, including regional meetings and safety summits.

The UAA also provided opportunities for members that found travel a challenge.

- More than 1,100 members attended one or more of the 12 webinars presented last year.

Developing and promoting industry standards and best practices are other areas of focus at the UAA. In that regard, 2019 was a productive year!

- Representatives actively participated on the Z133 and A300 committees.
- The Utility Tree Risk Assessment (UTRA) best management practice (BMP) was finalized and is now available at the ISA bookstore.
- UAA members led the development of the new A300 Part 7 standard for integrated vegetation management (IVM) and a second team was formed to rewrite the companion industry BMP.

- Both the Safety and Environmental Stewardship committees published self-assessment tools that are available to all members.

One of the strategies the UAA has pursued for years is supporting or partnering with others who have similar values and goals. In 2019, the UAA continued to pursue effective relationships:

- The UAA continued to partner with Arbor Day to host the Trees & Utilities conference.
- We provided financial support to RISE (Responsible Industry for a Sound Environment) and SUFC (Sustainable Urban Forestry Coalition).
- We partnered with the Rights-of-Way (ROW) as Habitat Working Group and others (First Energy, Corteva) to host our first regional Environmental Summit.
- The UAA worked with the ISA to develop the utility track at their conference and agreed to partner on the publishing and marketing of the industry BMPs (UTRA in 2019; IVM and Utility Pruning of Trees in 2020).
- Our friends at the Wildlife Habitat Council will be working with the Environmental Stewardship and Trees & Utilities Program committees to present a pre-conference workshop at this year's Trees & Utilities conference.
- While I am speaking of partnerships, I should take a moment to specifically acknowledge the recent assistance of the ISA. The UAA board has been considering how to staff and manage this growing organization and we have received assistance and advice from both the ISA's board and their executive director, Caitlyn Pollihan. In 2019, the UAA and ISA signed a new memorandum of understanding (MOU) and the work on the BMPs is the first of the outcomes. Our two organizations have supported each other for more than 40 years and both are looking forward to the next 40 years of collaboration.

These accomplishments are only part of the story. All of our committees had great successes—2019 was a great year!

Diona Neeser and Renee Phillips, the UAA's two-person staff, deserve a lot of credit. Even they, however, could not produce these results without a lot of help. The UAA has hundreds of volunteers giving back to the industry, which has allowed them to be successful. The 5,000 members of the UAA owe both of these true professionals our thanks.

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Industry News

Wright Tree Service Acquires Flory Backhoe, Inc. Assets, Adding New Services in the Midwest

Wright Tree Service, an employee-owned company specializing in utility vegetation management (UVM), expanded their services in the Midwest after acquiring the assets of Flory Backhoe, Inc.—a Kansas-based excavation company founded in 1999.

With this transition, Wright Tree Service will begin offering additional services in the Midwest, including: right-of-way (ROW) preparation and restoration, utility installation in housing developments, agricultural conservation, and residential excavation.

The employees of Flory Backhoe, Inc. will join the Wright Tree Service family under the management of Regional Manager Greg Williams.

"We're excited to announce this acquisition of assets," said Williams. "Our companies offer services that complement each other well, and are both built upon the same core values of quality service and integrity. We can take our resources and manpower on the Wright side and continue building on the foundation they've already established in the Midwest. The decision to pursue this venture will support Wright's long-term growth strategy and will give us the ability to provide new lines of service for our current and future customers.

Operations Manager Blaine Flory (left) and Project Manager Mark Flory (right).

ACRT Services Promotes Maegan Mullinax to Business Development Manager

Maegan Mullinax

The ACRT Services family of companies—ACRT, ACRT Pacific, and Bermex—offer expert independent consulting solutions to utilities and associated organizations throughout the U.S., including vegetation management (VM) consultation and training, customized safety courses, technology solutions, and utility metering services. An employee-owned organization that focuses on empowering employees, customers, and the communities they serve, ACRT Services is proud to announce the promotion of Maegan Mullinax to business development manager.

In 2018, Mullinax joined the Ready Force team as a roving utility forester with ACRT. She has served the organization as an area safety representative, a safety committee member, and as a storm response team member. As a business development manager, Mullinax will be responsible for growing the organization by offering the full suite of independent consulting solutions provided by ACRT Services.

"Maegan is a wonderful addition to our business development team," said John Wasmer, executive vice president of revenue at ACRT Services. "She has an extensive background in our industry. This allows her to solve the challenges our customers face. I know she'll thrive in her new role and look forward to her contribution to the industry and our organization." Mullinax is an ISA-Certified Arborist, a member of the ISA Southern Chapter, and member of the Fort Oglethorpe, Georgia Tree Board. She is also a member of the Veterans and Citizens Council in Fort Oglethorpe, the Georgia Tree Council, and the UAA, where she sits on the Professional Development Committee.

Having gained 10 years of experience in the field of horticulture, Mullinax was ready to take her passion for the green industry to the next level. She furthered her experience in the world of arboriculture by serving as a city arborist and later entered utility arboriculture as a system arborist for a cooperative in southeastern U.S.

"I love that our organization is employee owned and that we continue to maintain our independence," Mullinax said. "I believe that my background in both urban forestry and horticulture will allow me to bring some out-of-the-box thinking to my new role."

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UAA Events Committee Update

By Michael Sultan, Business Developer, Davey Resource Group and Brandon Hughson, Director of VM Services, Rainbow Tree Company

We are fortunate to be identified as essential and have the ability to continue working during this pandemic. Unfortunately, we have had to cancel several of our scheduled regional events. Currently, we have postponed all events through the end of May 2020 and are looking for opportunities to reschedule some of them. We are closely monitoring conditions and will continue to keep you updated about the status of upcoming events still scheduled.

What to Look For

We have several UAA and partner events planned for 2020. Keep checking the UAA website for registration details and updates regarding cancellations.

- **April 2020** - Southern Chapter ISA Conference, *canceled*
- **May 2020** - UVM Summit, *to be rescheduled*
- **June 2020** - Texas Regional Meeting | June 16-17 *NEW*
- **September 2020** - Trees & Utilities | September 14-17
- **October 2020** - Ohio Regional Meeting | *tbd*, New York Regional Meeting | October 14-15, Western Regional Field Day | *tbd*
- **November 2020** - Partners in Community Forestry | Nov 17

As we answer questions and consider circumstances that are new to all of us, we design solutions to challenges, we create different opportunities to connect with people, and continue to improve for the future. That is how the Events Committee is embracing what we don't know—it becomes a spotlight on learning.

Imagine the potential for new topics and presenters at future educational events—logistical issues, succession plans, and expanded health/safety concerns.

12 Months in Review

We provided our last committee update in May 2019. In the last 12 months, the Events Committee has worked with UAA members and partners to provide the following events:

- **April 2019** - Southern Chapter ISA Conference utility track
- **May 2019** - UVM Summit
- **September 2019** - Trees & Utilities
- **October 2019** - Ohio Regional Meeting, New York Regional Meeting, Western Regional Field Day

Regional Representation

Last year, the Events Committee mapped our U.S. membership by state simply to get a better understanding of our member distribution. This has been a useful tool to begin identifying geographical gaps in where we are offering opportunities for learning. Our decision to host a regional meeting in Texas is the first new meeting to come out of that exercise. Since then, we have mapped our membership to a more granular level with the goal of more targeted strategic planning efforts.

New Committee Members

Before identifying new members to this committee, we would like to take this opportunity to acknowledge Jimmy Williams' departure from our industry. Williams selflessly served our industry, the UAA, and the Events Committee for many years. Thank you, Jimmy.

I also want thank our newest members—Matt Searels and Ben Keck. We are always excited to welcome new members who bring energy, passion, and ideas.

Support for UAA Events

Support for UAA events comes in many forms—financial sponsors, exhibitors, volunteers, presenters, etc. Our events would not be possible without this assistance. Engaging sponsors and exhibitors are a key function of this committee and allows the UAA to deliver high-quality training and programs to our members at a reasonable price. We appreciate our current and previous partners and look forward to welcoming new UAA partners.

Giving Back

Are you planning to attend any of the UAA regional meetings, safety summits, or national events this year? If so, we can always use help staffing the UAA booth, and there is a lot going on behind the scenes at each event where a few extra hands are always appreciated.

If you plan to attend an event and are interested on how you can help, please contact Diona Neeser for more information and to sign up: *dneeser@gotouaa.org*.

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Using IVM Best Practices to Manage ROWs

SPONSOR SPOTLIGHT

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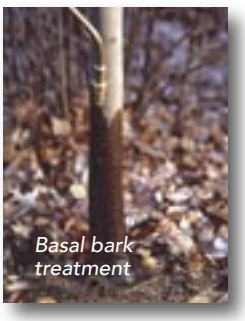
Overgrown ROW before IVM

Utility companies and their contractors are constantly battling unsuitable vegetation on their rights-of-way (ROWs). Therefore, utilities often spend a large portion of their budget on vegetation management (VM). The overwhelming size of a grid system, along with the impact of Mother Nature and budget constraints, can severely hinder a utility's efforts to maintain or reclaim a ROW. An integrated VM (IVM) program can help reduce long-term costs, but properly implementing IVM requires expertise in selecting and applying the right treatments.

Asplundh Tree Expert, LLC utilizes the latest equipment and best management practices (BMPs) when conducting herbicide applications in the field. Through IVM, a combination of mechanical services and herbicide applications are used to reclaim and maintain ROWs, ensuring the safe and reliable delivery of power sustainably.



Basal bark treatment

Reclaimed ROW after implementing IVM

Ultra-Low Volume Basal Bark & Cut Stump Treatment

Regardless of other factors, every VM program should implement an effective basal bark and stump treatment system. This is a simple task that can be completed by full-service spray crews, arborists, and foresters who maintain an active herbicide applicator license. Both applications can be completed year-round to provide the highest level of plant control.

Cut stump treatment

Cut-Stubble Treatment

If a ROW is too overgrown to effectively spray, it must first be reclaimed by physical means, such as mowing and hand-cutting. Once reclaimed, the next step is maintaining a compatible plant community. Following the mowing and hand-cutting, a cut-stubble treatment should be applied, which is supervised by state-certified herbicide applicators to expose cut surfaces and soil. The cut-stubble broadcast herbicide application utilizes soil-active herbicides, such as Tordon 22K, Viewpoint, Polaris, Method 240 SL, and/or Milestone. Herbicides can provide the most cost-effective approach for long-term ROW management. This particular application process also focuses more on below-ground root biomass control. By combining these two methods, incompatible vegetation is controlled, enabling desirable grasses, forbs, and other compatible species to cover the ROW. This creates an early successional habitat, encouraging a change in species composition and creating a home to various wildlife, such as deer and songbirds, while promoting a healthier pollinator habitat with native flowering plants.

Cut stubble application

ROW after implementing cut-stubble treatment

Once the site is recovered, ongoing costs are reduced. Maintenance becomes a matter of implementing an affordable, ultra low-volume application program using backpacks to maintain native, low-growing plant communities.

SPOTLIGHT on the Environment

NASA IMAGE

The State of Corporate Conservation

By Margaret O'Gorman, President, Wildlife Habitat Council

Margaret O'Gorman is the author of Strategic Corporate Conservation Planning: A Guide to Meaningful Engagement, which offers fresh insights for corporations and environmental groups looking to create mutually beneficial partnerships that use conservation action to address business challenges and realize meaningful environmental outcomes.

The current biodiversity crisis is being called the sixth extinction. Studies show declines in our insect, bird, mammal, and amphibian populations. There is not a single taxonomic group that is increasing in numbers. According to the International Union for the Conservation of Nature, more than 28,000 species are threatened with extinction.

Biodiversity touches every aspect of our lives—from the clothes we wear to the cars we drive. Everything we eat, drink, work with, play with, and dispose of has an impact on biodiversity. Yet, while loss of biodiversity is increasing at an alarming rate, we aren't talking about it. A study last year found that the biodiversity crisis gets eight times less coverage in the news media than the climate crisis, even though both issues generate the same number of reports and research studies.

Despite the lack of attention, there is room for optimism. Every company Wildlife Habitat Council (WHC) works with, many with UAA representation, is deeply and impressively engaged in addressing their contribution to biodiversity, looking not just at the footprint of operations, but also at the opportunities across the supply chain, in their communities, and around capital projects. Few stakeholders know that these efforts

represent more than two million acres of land managed for conservation by fewer than 100 companies. Close to one percent of the effort are credited to the utility sector in North America.

There are also signs that global interest in the environment is increasing. A survey by the Pew Research Center found that 74 percent of Americans said the country should do what it takes to protect the environment. The latest Eurobarometer measure of the concerns of European citizens saw anxiety for the environment rise to be the fourth most concerning issue out of 13. The World Economic Forum listed biodiversity loss in its Global Risks Report as having an above-average likelihood of occurring and causing an above-average impact on the global economy.

This year is showing not just increased interest, but also action. The Convention on Biological Diversity will host a high-profile Conference of the Parties (COP) meeting to agree on its post-2020 global agenda for nature and has, for the first time, officially embraced the idea of mainstreaming biodiversity into industry, empowering companies to have a positive impact. Also this year, Earth Day celebrates 50 years of activism, and the Smithsonian Institute Earth Optimism Summit is ready to showcase what is possible, what can work, and what is being done across the planet. Many are calling 2020 the "Super Year for Nature."

Many are calling 2020 the "Super Year for Nature."

Nature-based solutions are finally being valued. After decades of plans, reports, and endless studies, there is a growing appetite for accessible biodiversity projects compatible with operations that support watershed quality, resilient ecosystems, and healthy communities. From tree plantings "having mind-blowing potential" to tackling the climate crisis to rights-of-way (ROWs) supporting at-risk communities of pollinators, more and more examples of corporate conservation successes at all scales are becoming mainstreamed into business operations.

Nature-based solutions to solve problems in the built environment are also gaining traction on corporate lands and in communities. They have the potential to contribute one third of the solution to the climate problem and provide untold co-benefits for biodiversity.

Given the severity of the problem, we need these trends to cause a contagion of interest. Concern for biodiversity can be infectious, but too many companies don't know the potential of their lands to make a positive difference and too many non-government organizations (NGOs) see companies only as potential funders, not partners. Only 15 percent of lands worldwide are protected for nature, so all lands are needed to save nature, especially privately owned corporate lands that can be managed for biodiversity, whether as an operational necessity or through a beyond-compliance approach.

Nature is amazing. It is resilient. It is responsive. But it needs our help right now. With a growing awareness for the plight of biodiversity and an increasing understanding of the power of conservation action, we can harness corporate lands to solve this global crisis and establish a new way to live and, most importantly, work in harmony with nature.

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Research Corner

RESEARCH STUDIES: TECHNICAL REVIEW

The Association Between Natural Braces and the Development of Bark-Included Junctions in Trees

This technical summary is based on a peer-reviewed article published in The International Journal of Urban Forestry. 40(1):16-38, Slater, D.

Challenge

Research has shown included bark substantially weakens junctions, prompting increased risk of limb failure. However, the factors associated with the development of bark-inclusions on branch junctions are unknown. Having an understanding of the major factors associated with the development of bark-inclusions on branch junctions can aid in the identification of branch junctions prone to failure.

Main Objectives

This study sought to determine if natural bracing is a major factor in the formation of bark-inclusion on branch junctions. Further investigation of natural bracing within this research includes the frequency of limb interaction restricting the movement of a junction, the presence of a seam on the bark within the junction, presence of bulged bark-included junctions, and if significant differences between tree species and the formation of bark-includion on branch junctions exist.

Process

The survey included a cohort of 1,987 broadleaf trees where data was recorded, including cohort details, natural brace location, height above the bifurcation, bifurcation classification, junctions with noticeable bulges, and the type of natural brace (fused limbs, entwining stems, entwining branches, crossing limbs, crossing lateral branches on stems, intermeshing twigs, resting stems, climbing plants acting as braces, and/or complex braces) present.

Conclusion

Of bark-inclusion branch junctions, 93.9 percent did not have any bulging present and exhibited the presence of one or more of the natural braces above those branch junctions. Additionally, 93.3 percent of bark-inclusion branch junctions that exhibited a major bulge were strongly associated with the absence of natural braces.

Utilities Moving Forward

The findings in this paper will aid in the development of recommendations for identifying the likelihood of failures within the natural bracing of trees in a future companion paper. Other future work is needed to investigate natural bracing having a direct link on the cause of bark inclusion on branch junction development.

Written by Jenna Paul, Technical Writer, Davey Resource Group, Inc. (DRG) with technical review by Dr. Anand Persad.

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A New Perspective: Drones in VM

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ACRT Pacific employee Billy Graham is doing exactly that. When his wife bought him a drone for his birthday several years ago, Graham saw an opportunity to capture imagery of work being performed in the field—an offering that not many utilities service companies provide.

With organizational support, Graham became a Federal Aviation Administration (FAA) licensed pilot for commercial drone operation, enabling him to understand and confirm all potential aerospace restrictions on drone usage and to ensure its safe commercial operation.

Using his drone to capture photographs and videos, Graham is now able to provide an entirely new perspective on the work ACRT Pacific manages for our clients.

"Drone imagery is a great way to enhance our services to customers," Graham said. "A picture is worth a thousand words, so being able to tell the story from a new angle adds incredible value. It demonstrates the value and impact of our work and our focus on safety."

Using his drone, Graham has been able to bring his passion into the workplace. But its value doesn't end with utilities alone. Imagery captured in the field has helped to build camaraderie with contract tree crews, who use the photos for training purposes and project documentation. His work provides a much needed emphasis on the importance of safety for all while working in the field.

Learn more about ACRT Pacific and our work for utilities at *pacific.acrt.com*.

UVM and Technology Should be a Partnership

Randall H. Miller, Director of Research and Development, CNUC

We are in a golden age of technological advancement in utility arboriculture. Utilty arborists are rightfully interested in applying technology to optimize efficiency and quality control. This issue of Utility Arborist *Newsline* is one of many devoted to technology. Technology is also a common topic at utility vegetation management (UVM) conferences, including Trees & Utilities, Environmental Concerns in Right-of-Way Management Symposia, and CEATI. In March 2019, the Wildfire Technology Innovation Summit in Sacramento was dedicated entirely to applying technology to prevent tree-powerline-caused fires in California. The list goes on and on.

Technological applications applied to UVM include high-resolution LiDAR; satellite imagery; PhoDAR; drones; GIS-based program management software; application of mobile devices to enhance communication between management, supervision, and the workforce; and weather modeling. These enhancements among others are becoming indispensable for program managers.

Even so, I am concerned that many of these technological advances are being advocated as ends unto themselves. Engineered solutions to VM issues are too often promoted as a replacement for utility arborists. An illustrative example comes to mind from the 2019 Arboriculture Australia conference I attended. One of the presenters was an economist who offered results of a global UVM benchmark survey she conducted. She declared the best-in-class program was in Spain, where just two managers ran an entire program using computers—without ever leaving their offices. No boots on the ground needed other than tree crews—all due to the magic of technology. I have no doubt she is a brilliant economist, but her VM advice is folly. I left wondering how many economic conferences would invite arborists to lecture on economic best practices. I doubt any, and for good reason—our economic expertise is no more worthwhile than an economist's arboricultural recommendations. The same is true of other technocrats.

I have a similar impression from other venues. Often, technology presentations are offered by information technology (IT) salespeople who oversell their systems. For example, I have heard LiDAR promoted as capable of identifying tree species. I have yet to see it. When I asked one presenter how LiDAR could achieve species granularity, their answer was that it required repeated

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feedback from ground verification, and with enough examples, artificial intelligence will enable computers to zero in on a species level. I can buy that. There are applications people can use with their smartphones cameras to identify plant species. If other platforms can identify tree species, LiDAR probably can too. But, there's a lot of work to be done before we get there. For instance, when the urban forest at the University of Wisconsin, Stevens Point, was recently LiDAR-ed, the cupola of the Old Main Building was identified as a tree. No word on which species. My point isn't that LiDAR is ineffective—far from it. Rather, it is a tool to use to target areas for closer scrutiny. To be most effective, it needs to be used in partnership with qualified arborists in the field, rather than as a contrivance monitored exclusively from an office.

This idea was driven home at the Wildfire Technology Innovation Summit by California Public Utilities Commission Safety and Enforcement Division Deputy Executive Director Elizaveta Malashenko, who admonished a panel that they should be promoting their advances to augment, rather than replace, traditional VM. She's right. The idea of engineered solutions solely coming to the rescue of hapless arborists seems to be yet another instance of a lack of appreciation for the professional expertise required to manage the complexities of UVM. We must do a better job conveying our value than we do now.

We bring a lot of this disrespect on ourselves. We identify as "tree trimmers" and refer to our programs as tree trimming, even though we know that utility arboriculture is far more than that. Such demeaning terminology contributes to the widespread misconception that there is a lack of competency among utility arborists.

There are developers who agree with me. Joe Purohit of Ecolayers, LLC stresses their Tree Asset Manager is designed to work with existing systems. Another example is Bayer. At a conference in Saskatoon, Canada last march, Darrell Chambers shared high-resolution satellite remote imagery under development by Bayer, for which they plan to offer subscriptions to take frequent data on targeted areas (like powerlines), now at three-meter, but eventually down to five-centimeter, resolution. The data can be used to help practitioners target their resources. For example, imagery that shows a tree gradually leaning closer to powerlines might indicate it is failing for one reason or another, and ought to be scheduled for a field inspection. Chambers emphasized that the idea isn't to replace arborists, but to enable practitioners to use their resources more efficiently.

That should be the paradigm—partnership. Technology should improve UVM programs by helping us to use our limited resources more efficiently. In the March/April 2020 *Utility Arborist* Newsline, Will Nutter pointed out the difficulty the profession is having recruiting and retaining workers. Adequate program funding is also hard to come by. Yet, we know that a premise of integrated VM (IVM) best practice is to base prescriptions on data and facts. Technology can help us identify where to look and improve our accuracy. Technology can also help us streamline our data analysis, work assignments, tracking, and document workload, as well as justify the business case for UVM budgets. We don't have enough people to scrutinize and manage the multitude of trees under our management. Technology is an effective way to bridge the gap in our deficiency of human and monetary resources.

There is no replacement for competent field professionals. Remote sensing can't determine a proper collar cut, codominant stem, shear plane crack, overextended branches, or determine the existence of internal decay, asymmetrical hollow, pronounced bulges on trunks, or other tree defects that might be identified through a Level 1 or 2 assessment. Moreover, technology can't provide the one-on-one communication many property owners, land managers, and other stakeholders need for a successful UVM program. Qualified, trained arborists provide these and many other programmatic benefits that technology alone cannot. Practitioners on the ground are necessary to augment remote sensing, ensure quality control, and deliver optimal programs.

What's more, technology doesn't need to be oversold as a singular solution for it to be welcomed into utility arboriculture. We need it. But we shouldn't apologize for our expertise and what we offer. Our understanding of how to manage dynamic natural systems is essential to solve the difficult problems attendant to ensuring safe, flawlessly reliable energy while promoting environmental stewardship. Those skills are outside the expertise of technocrats. Technology will continue to transform UVM. It will be a positive force only if applied as an enhancement to skilled, knowledgeable arboricultural professionals who use it to optimize limited resources.

It's all about partnership.

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Putting UVM on the Assembly Line

Effective UVM Through Integration of Workforce, Planning, and Technology

By Jarod Cassada, Managing Member, CVMC, LLC and Michelle Vignault, Marketing and Communications Manager, Clearion

Henry Ford showed the world a better way to produce cars in 1913. Since that time, the manufacturing industry has steadily improved upon his methods. Better planning, improved technology, and highly skilled workers have pushed productivity, cost management, and quality control to new limits. How do we apply the valuable lessons learned in manufacturing to an industry that does not work in the controlled environment of a factory setting? Can a well-designed vegetation management (VM) program take queues from the improvements on Ford's assembly line?

A utility VM (UVM) program manufactures a vital part of a greater finished product. That part is a "space" free from the interference of vegetation that allows for the safe, reliable operation of an overhead electric system. This space is a vital part of what the utility needs for their finished product to function properly. The factory floor where this space is created is the service territory itself. Put simply, a mile of overhead line at risk from vegetation enters the factory and a mile of line free from vegetation risk exits the factory. The UVM program is, metaphorically speaking, a line clearance factory in the space-making business.

UVM Factory Assumptions

- It is not cost effective to manufacture more "space" than what the system needs.
- The manufacture of "space" shall be managed to prevent product cost from exceeding the product value.
- The "space" has a finite lifespan and must be replenished to prevent defect in the operation of the power delivery "product."
- If the supply of "space" does not keep up with the demand for "space," the quality of the product will decline or fail. Organizational expenses will go up and inventory of "space" will go down as greater resources are allocated to fixing defective product (i.e., outages, reliability work, hot spotting, responding to customer demands). The price for "space" will go up as will demand for clear "space."

Little's Law I = R ÷ T

I = Inventory (the number of units within the system)
R= Flow Rate (the rate at which the inventory is replenished)
T= Time (the time it takes for the inventory to go through the process)

Example:

Inventory (I) = 20,000 miles of overhead line on a utility system to keep clear of vegetation "space."

The cleared space has a useful life expectancy of four years. So, Time (T) = 4 years.

Flow Rate (R) = 20,000 miles "space" (I) / 4 years (T) = 5,000 miles cleared "space" per year

The resources to clear 5,000 miles must be added to the inventory each year!

To place UVM onto the assembly line, a manager must integrate the workforce, planning, and technology.

The Workforce (Crew)

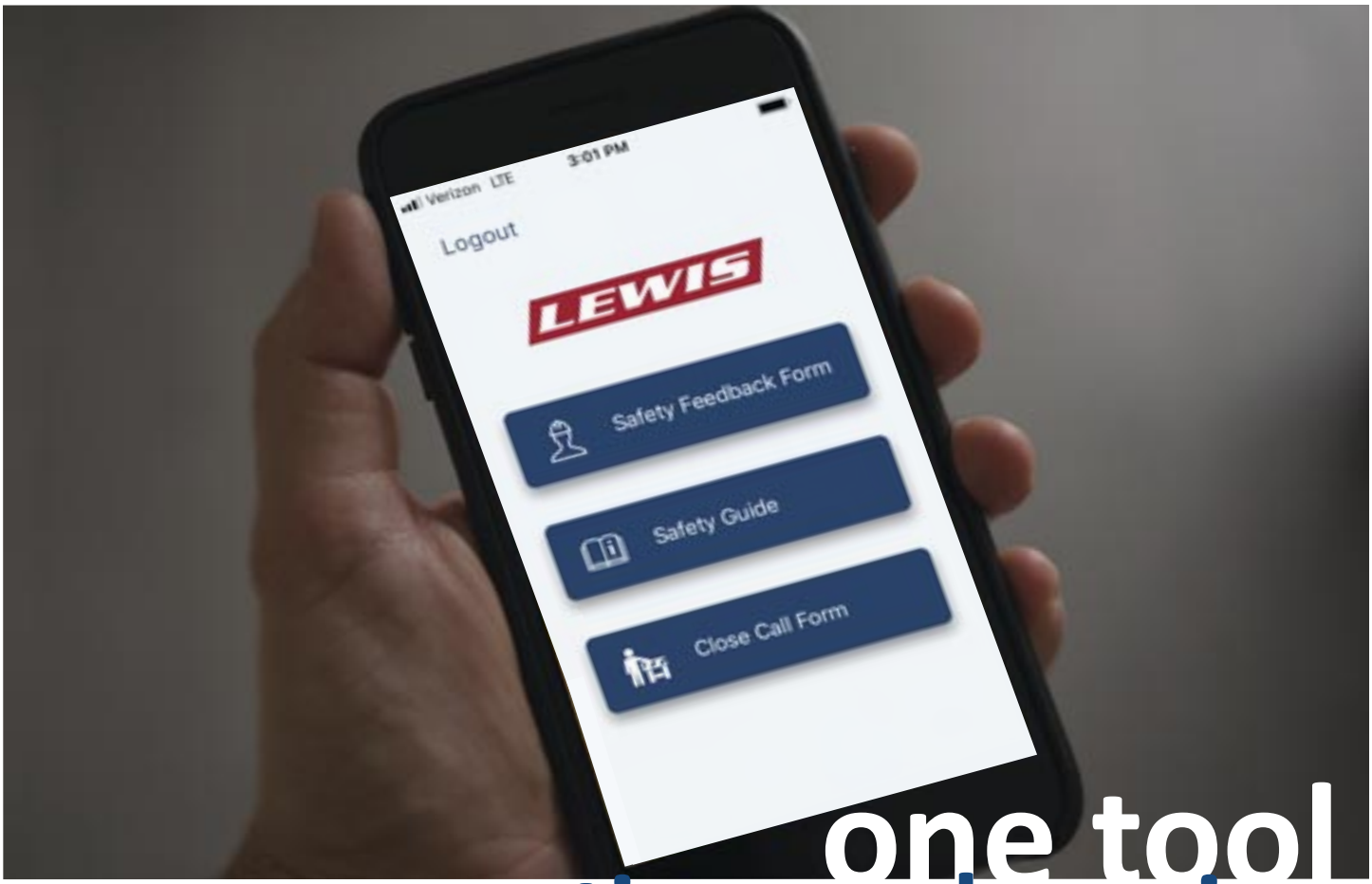
Skills are acquired with experience and time. Consider, for a moment,

Figure 1: The Clearion solution is an example of a technology that utility managers can integrate into their program. This diagram is courtesy of Clearion Software, LLC

military training as an example where skills ensure survival. Military training involves drilling and the repetition of activities until they become an acquired response. Line clearance workers do not learn the trade from reading. They must experience the work firsthand. A certain amount of time is required before a line clearance worker is well trained and able to recognize and mitigate hazards. It is longer still before they know what to do when encountering a migratory bird nest or how to assess a tree for growth characteristics and risk. Their knowledge becomes more invaluable as they learn the intricacies of a particular system. Skilled workers are difficult to acquire and replace. It behooves the manager to utilize the talents of a worker for the skills they have which cannot be substituted. This is similar to a tool in a factory. The tools are dedicated to certain tasks. Using a certain tool to perform other tasks may not be detrimental to the tool, but it keeps the tool from functioning in its best use. Consider delegating or removing all other tasks the arborist is performing, such as planning or notification, that can be done effectively with another tool. It is imperative the manager has an inventory of tools at his or her disposal and deploys them appropriately.

Planning

The workforce is expected to be productive. Productivity does not equate to efficiency. Efficiency is not necessarily effective. If tree workers are



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hitting all their productivity numbers, but the productivity is in excess of what is required, this is not efficient. If the productivity includes tasks that can be substituted for a lower cost method, the operation is less than effective. Planners can be used to identify what needs to be produced and determine the proper tool for that portion of the manufacturing process. The batching and timing of work is best managed through a technology solution to ensure the tasks are completed as efficiently as possible and that a surplus of space is not being manufactured. Figure 2 demonstrates some of the processes where planning and technology can be used to improve the line clearance product ("space").

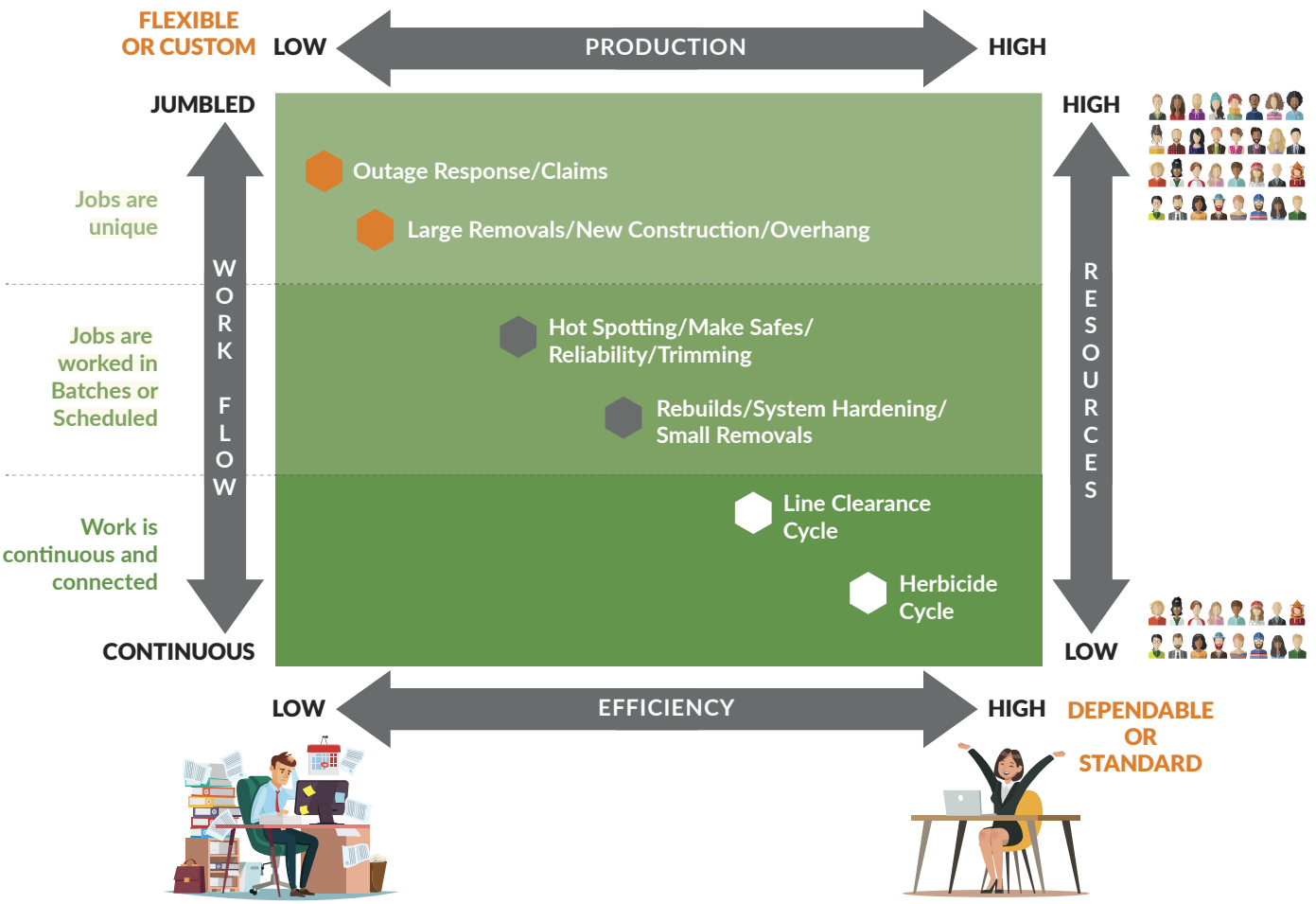
Figure 2 (Below): Hayes/Wheelwright UVM product-process matrix, courtesy of Clearion Software, LLC and CVMC, LLC

Technology

Utility work does not always start at one point and go straight through to another. Powerlines also do not cross areas that are homogeneous. The utility may be subject to regulatory changes, environmental stresses, or new demands from the customer. Although unique tasks cannot be avoided, technology can be used to exploit synergies and batch work. Hardware and software can be used to greatly improve organizational capability. Adding more information is like adding a bigger lever, allowing a manager to exhibit more effective force where it is needed. A higher order of technology allows a manager to add layer after layer of information in an organized fashion, creating a more complete picture and sharing that picture with a wider audience and stakeholders. It also allows managers to integrate information from other sources to focus resources where and when they will have the most impact. The more organized and available the date is, the easier it is to analyze.

Fewer required workers, increased reliability, improved safety, and/or environmental stewardship are all possible. The technology component empowers managers to gauge vital parts of the assembly line: cost, quality, and production. Working with a software solution that understands UVM is recommended to ensure the data and hardware are complementary to the production of "space."

Henry Ford demonstrated high efficiency with low resources with his assembly line. The UVM manager should strive to drive operations to the lower right corner of the matrix. The integration of contract planners and a software solution to track work flow with the workforce is



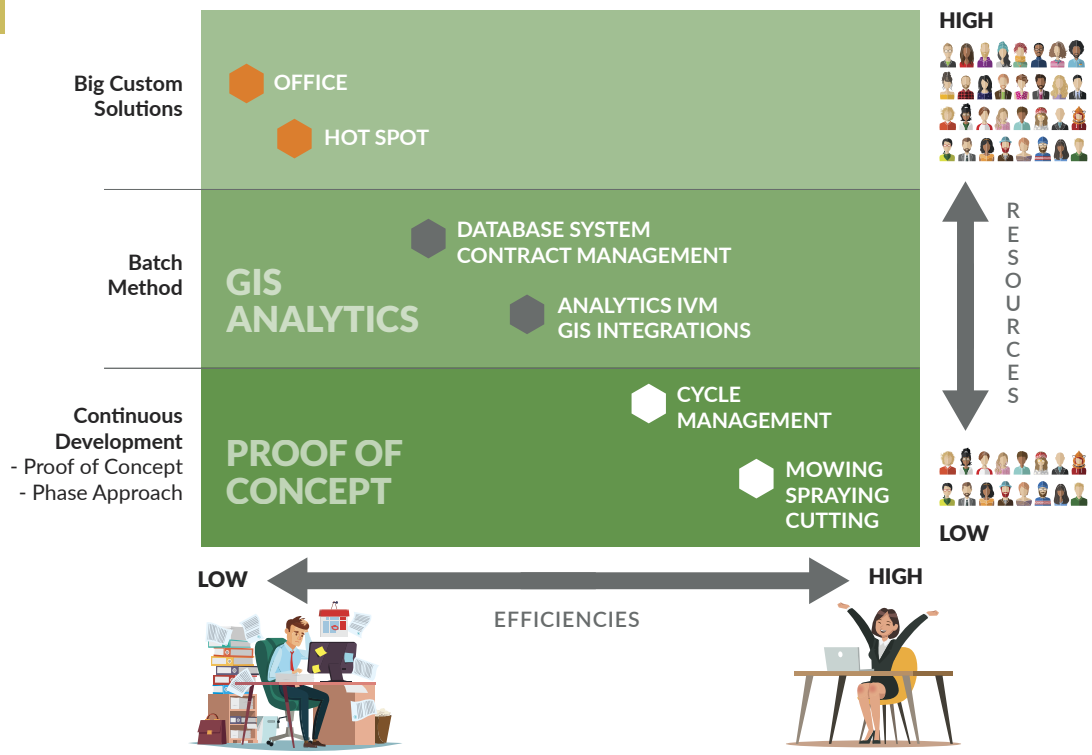
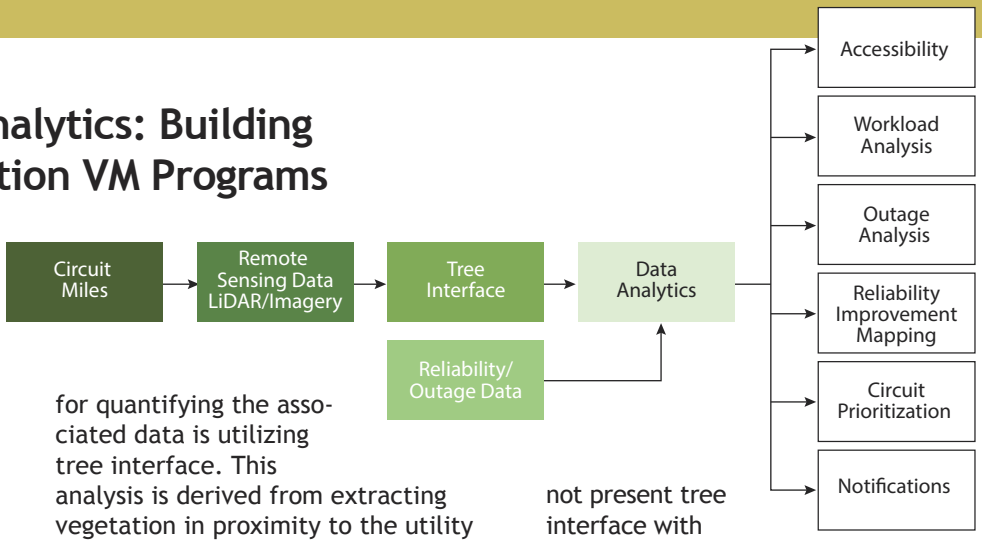


Figure 3: Hayes/ Wheelwright UVM efficiency-process matrix, courtesy of Clearion Software, LLC and CVMC, LLC

essential to finding synergies and batching jobs with similar characteristics, such as proximity to line, geography, accessibility, reliability risk, and environmental issues. Failure to use a higher order of technology is like building one car at a time. Although it provides great flexibility, it is expensive and requires a great deal of resources. Every utility should put their UVM program on the assembly line. UVM is more effective through integration of workforce, planning, and technology.

Remote Sensing and Analytics: Building Efficiencies in Distribution VM Programs

By Geoff Etzel, Regional Manager; Will Ayersman, Project Manager; and William Rees, Utility Consultant, Davey Resource Group



Technological innovations in the past decade have led to many improvements in the utility industry, and remote sensing is a notable example. Data derived from remote sensing can yield immediate improvements in productivity and reliability on electric distribution when integrated into a utility's vegetation management (VM) or asset management plan. Tree interface where trees pose risk to utility assets is one application which serves as a potent tool for understanding real workload and risk.

Since effective management starts with an understanding of these factors—risk and workload—Davey Resource Group, Inc's (DRG) solution for quantifying the associated data is utilizing tree interface. This analysis is derived from extracting vegetation in proximity to the utility rights-of-way (ROW) and calculating the linear distance of trees on a circuit-to-circuit basis. This has an application for assessment on any ROW. For overhead electric circuits, it is the examination of existing and emerging woody vegetation via data acquired through remote sensing.

Currently, utility VM (UVM) programs often use circuit mileage to express workload and tree-caused outage risks. This is an inaccurate method of prioritization, as many segments do not present tree interface with utility assets, instead only requiring floor maintenance and inspection to confirm or update clearance conditions. For example, when one overhead electrical distribution system of 21,700 miles was assessed for tree interface, only 6,192 miles—a mere 28 percent of total circuit miles—contained locations that pose true vegetation outage risk. As a result, DRG's tree interface reliability modeling was able to reduce the number of target circuits by 20 percent compared to

traditional circuit mile models, freeing up money to address other problematic issues on the system.

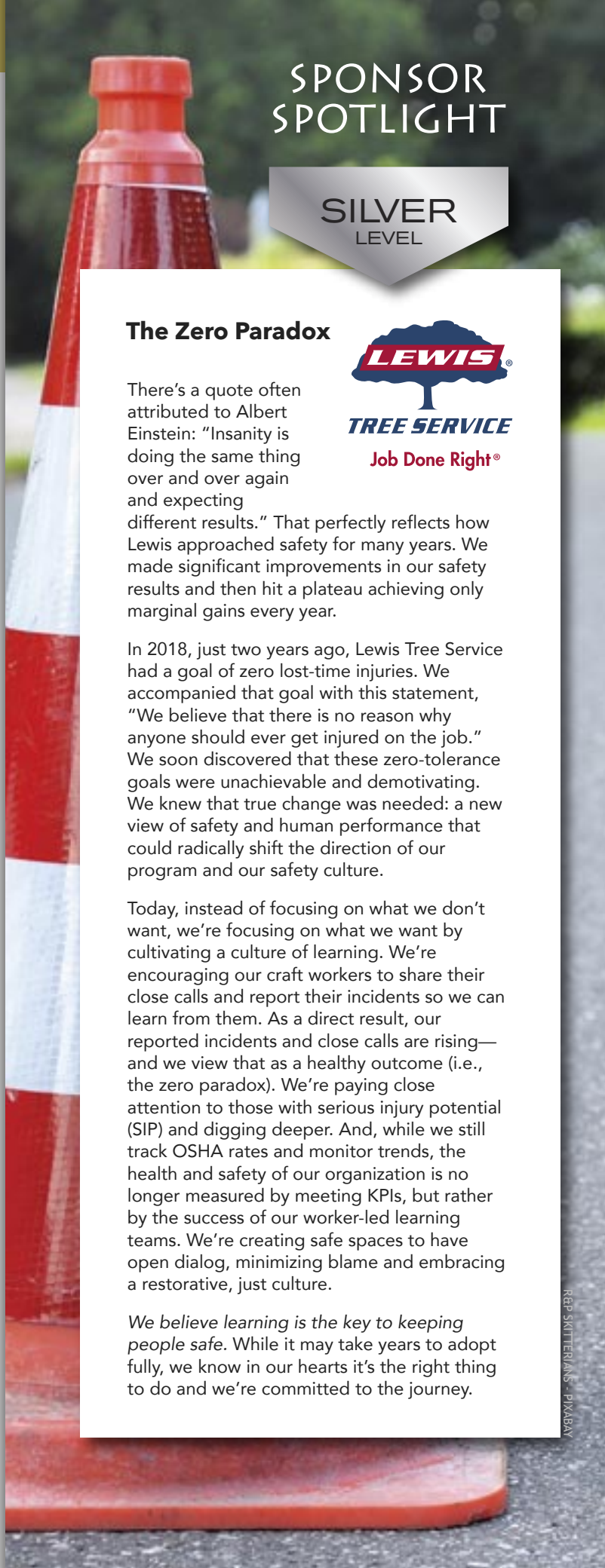
For the process of determining tree interface, DRG utilizes an automated machine-learning feature extraction process to analyze data often provided by LiDAR, though other methods may be used, and additional high-resolution imagery to assure quality control. The extraction process relies on vegetation-specific algorithms to identify tree-covered areas within each LiDAR or orthoimagery tile. These tree recognition workflows are critical to provide separation of woody and non-woody vegetation into GIS-based data sources. Once extracted, all woody, tree-related data are aggregated and summarized to calculate total acreage and percent of tree area posing risk to the distribution or transmission ROW corridor. The final step transforms tree data into linear line segments for the tabulation of tree interface in units of feet or miles.

Once DRG has the final dataset for the tree interface, it can be used to populate a risk model which allows higher priority areas to be targeted. By focusing on the most problematic tree miles, reliability metrics can be increased efficiently. This circuit prioritization through normalization is a more strategic methodology for planning out workload than that of the traditional circuit miles approach. In addition to prioritizing circuits for trimming, this process can also provide opportunities to modify trimming tactics to surgically address problematic areas, such as overhanging branches, that are not typically part of the VM standards for certain circuit segments.

While two circuits may have equivalent miles of overhead wire and similar reliability scores, their tree interface may differ, and focusing on the one with less interface will prove more efficient and effective. The strategic planning this allows for can greatly increase reliability metrics while reducing expenditures. This helps cost per mile, as well as time and material contracts to get an accurate assessment of where they are losing money, and can even direct tree crews to areas for reliability enhancement VM.

The investment of conducting tree interface analysis results in the acquisition of data that remains relevant long past the date it was acquired. This is due to the fact that tree interface is largely static; vegetation takes substantial time to grow and presents a risk to the overhead system. This results in the longevity of the tree interface data being analyzed over a maintenance cycle.

By using the Tree Interface Analytical Modeling process, it will help increase confidence levels in the areas of risk exposure, workload, manpower requirements, budgeting demands, and reporting. From tree interface analysis, predictive analytics can be generated for where utilities may want to focus trimming efforts to remediate outage potential. This can help ensure that utilities are focusing their resources on generating the most improvement, substantially decreasing the number of tree-related outages.



The Zero Paradox

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There's a quote often attributed to Albert Einstein: "Insanity is doing the same thing over and over again and expecting different results." That perfectly reflects how Lewis approached safety for many years. We made significant improvements in our safety results and then hit a plateau achieving only marginal gains every year.

In 2018, just two years ago, Lewis Tree Service had a goal of zero lost-time injuries. We accompanied that goal with this statement, "We believe that there is no reason why anyone should ever get injured on the job." We soon discovered that these zero-tolerance goals were unachievable and demotivating. We knew that true change was needed: a new view of safety and human performance that could radically shift the direction of our program and our safety culture.

Today, instead of focusing on what we don't want, we're focusing on what we want by cultivating a culture of learning. We're encouraging our craft workers to share their close calls and report their incidents so we can learn from them. As a direct result, our reported incidents and close calls are rising—and we view that as a healthy outcome (i.e., the zero paradox). We're paying close attention to those with serious injury potential (SIP) and digging deeper. And, while we still track OSHA rates and monitor trends, the health and safety of our organization is no longer measured by meeting KPIs, but rather by the success of our worker-led learning teams. We're creating safe spaces to have open dialog, minimizing blame and embracing a restorative, just culture.

We believe learning is the key to keeping people safe. While it may take years to adopt fully, we know in our hearts it's the right thing to do and we're committed to the journey.

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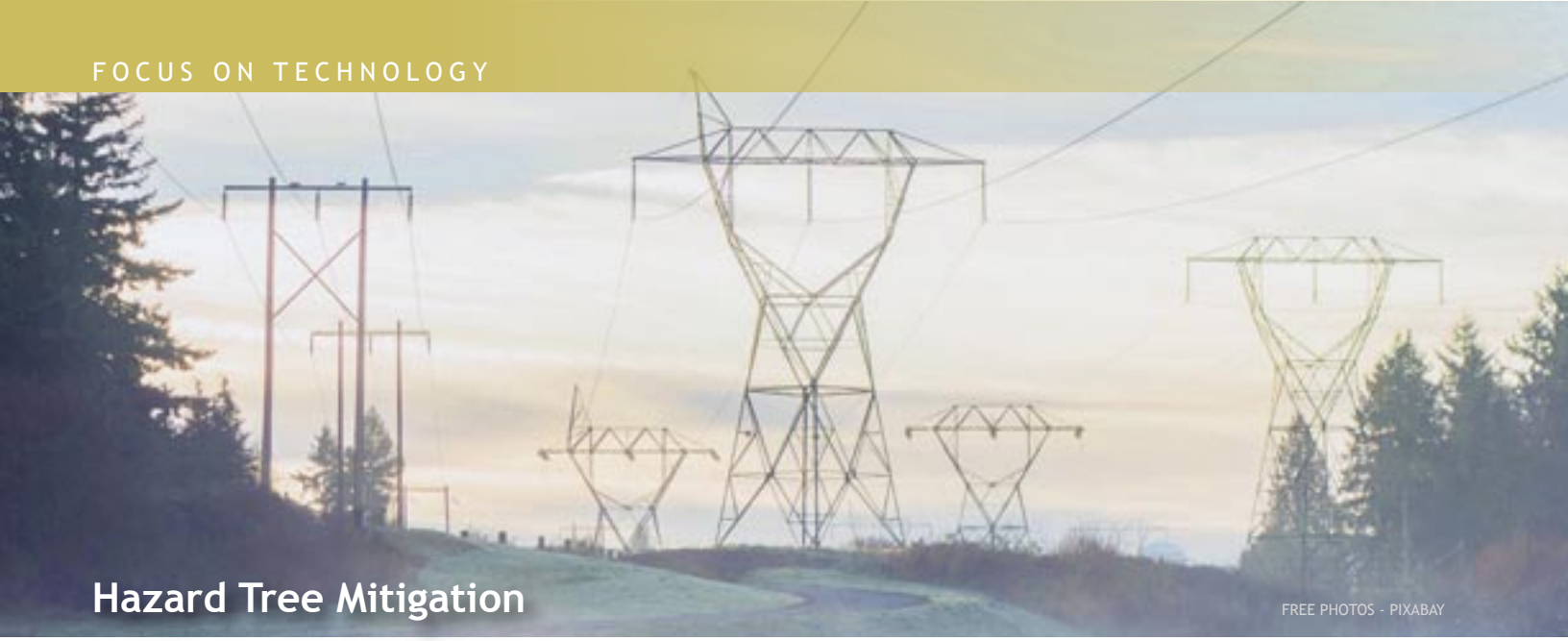

Hazard Tree Mitigation

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Adapting to the New Normal in a Changing Environment

By Scott Bernhardt, Northwestern Energy and Nathan Jones, Terra Spectrum Technologies

"Better the devil you know than the devil you don't" the old saying goes, referring to the problems associated with quantifying and managing an unseen opponent. In the utility vegetation management (UVM) world, the unseen adversaries lying in wait on a power system are dead or dying trees that threaten to fall into conductors—hazard trees. Hazard trees can severely impact the reliability of an electric system and require different tactics than traditional cycle maintenance to successfully mitigate.

While all programs grapple with hazard trees in some fashion, systems that experience large-scale tree health problems are at especially high risk. The past several years have seen a vast mountain pine beetle (MPB) outbreak in the western U.S., forcing utilities in affected areas to rethink how they implement their hazard tree programs and shift from a reactive to a proactive mindset. Northwestern Energy (NWE) is one such utility, with a significant portion of their system residing in the MPB-impacted high country of Montana. By employing aggressive mitigation techniques and using cutting edge software, NWE is able to effectively push back against a relentless adversary.

Hazard trees on the NWE system have been prevalent within the last decade. The MPB challenge caused NWE to think outside the box and employ a variety of tactics. The utility overlaid transmission and distribution (T&D) system maps with wildfire hazard potential and MPB mortality maps. They considered the amounts of infrastructure in these areas, as well as analyzed past vegetation-caused outages to ultimately develop a risk matrix. Work started with the highest perceived risk and continued in areas with lower overall scores. Full-blown logging operations were used to take down hundreds of trees per span that were dead, dying, or had structural defects.

With FieldNote, the new software from Terra Spectrum Technologies™, NWE found multiple ways to improve the data required to justify yearly budgets, including tracking 7,200 miles of annual aerial patrols of the transmission system. The app was quickly configured to track the location of hazard trees throughout the system. Most of the hazard trees were beyond the utility's permitted width, and negotiations were required to remove them. A refusal process for unsuccessful negotiations was implemented and documented within FieldNote to track that utility representatives met with the landowners and offered to remove the trees safely before they failed. Another benefit of using FieldNote was the ability to plan and assign work to crews in minutes.

Even though NWE is most of the way through the MPB epidemic, feedback from data being collected indicates different challenges coming down the pike within the service territory. Approximately one-third of hazard trees currently being removed are Douglas-fir (*Pseudotsuga menziesii*), and the population of spruce budworm (*Choristoneura*) and Douglas-fir beetle (*Dendroctonus pseudotsugae*) are on the rise. Ash trees (*Fraxinus*) on the system are also being inventoried in the event the emerald ash borer (*Agrilus planipennis*) (EAB) decides to make NWE's service territory its home.

One of the many impacts of a changing global climate, declining forest health is an issue that is unfortunately here to stay. Utilities are adapting to the new reality that vast sections of their systems are being impacted by climate-driven vegetation problems. While large swaths of trees can quickly die and become immediate fall-in threats to the integrity of the power supply, another danger looms even larger than reliability: wildfire. As utilities in California have recently discovered, trees falling into conductors can cause large-scale remote wildfires that are difficult to contain, extremely costly, and can take human lives. Taking a measured, proactive approach while managing hazard trees will not only reduce costs in the long run and boost reliability, but will also help to reduce the risk of catastrophic wildfire.

DTE Energy Leverages High-Density Distribution LiDAR in Detroit

Figure 1. DTE's 2018 project area, above, contains more than 2,300 miles of distribution and sub-transmission lines that Quantum Spatial acquired high-density LiDAR data for VM analytics.

The total ROI for the data-gathering technology was 10.5 times the initial outlay for the utility.

By Craig Jackson, Manager of Forestry Planning, Auditing, and Herbicides and AJ Smith, Regional Forester, DTE Energy

Two years ago, DTE Energy faced a limited operations and maintenance budget for vegetation management (VM) along with territory-specific challenges. The Detroit-based energy company's goal was to find a way to decrease vegetation-related outages while optimizing its VM budgets.

To better understand the risk across DTE's system, the utility considered implementing a LiDAR survey to provide highly accurate measurements of vegetation proximity to conductors of highly regulated transmission lines administered by the North American Electric Reliability Corporation (NERC). LiDAR surveys are also playing an integral role for utilities looking to transition from cycle-based maintenance to condition-based maintenance.

DTE was also interested to find out if LiDAR analytics could provide similar accuracy and value to distribution lines to provide a return on investment (ROI) that could lower the utility's VM spending.

Gaining Insight into Pressing Problems

To test the capability to provide the desired ROI from the LiDAR project, the utility looked inward at its service territory. DTE's service territory contains roughly 31,000 miles of distribution lines and sub-transmission lines. Partially due to Detroit's economic downturn, DTE faces challenges caused by population loss and urban blight, which left the utility with less customers and also stressed its VM budget.

The downturn also left Detroit with rising safety concerns and access issues, which resulted in a decade of zero maintenance for some regions. A significant amount of the distribution rights-of-ways (ROWs) contained dense vegetation that posed substantial outage risk to DTE's system and customers.

These circumstances made Detroit a suitable project area for remote inspections. The project enabled DTE to test LiDAR's ability to identify, measure, and prioritize risk to potentially provide an ROI that could enable DTE to maintain or reduce its current VM budget.

Performing a LiDAR Inspection

DTE engaged Quantum Spatial to plan and perform a wide-scale LiDAR collection to test the technology's efficacy for distribution VM in Detroit. Quantum Spatial collected the LiDAR data via a Piper PA-31 twin-engine aircraft equipped with a Riegl 1560i LiDAR sensor acquired and delivered it to DTE prior to the year's end—only 16 days after project initiation.

The project resulted in a raw and classified LAS point cloud with an average point density of 32 points per square meter (ppsm). The LiDAR survey produced several valuable data sets that would contribute to DTE's VM strategy.

Editor's Note: This article will also appear in T&D World's 2020 Vegetation Management Supplement—which is published in partnership with the Utility Arborist Association.

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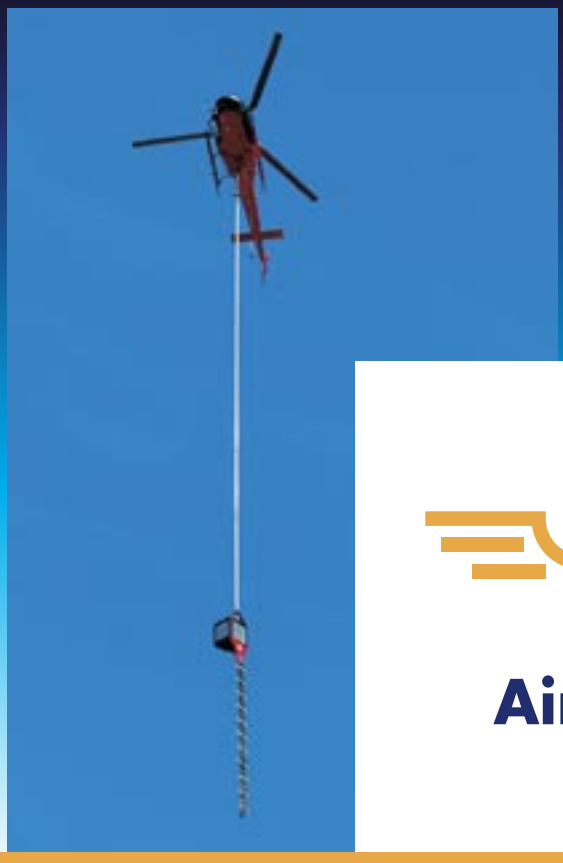

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Critical to DTE, the survey identified all vegetation encroaching or tall enough to strike DTE's conductors, providing a comprehensive and detailed inventory of the project area's vegetation threats. These threats were classified according to their proximity to the nearest primary wire, as well as by their potential to fall-in, or to overhang above the wire by up to 15 feet.

DTE also received a full inventory of vegetation encroachment by volume. The encroachment was broken down into priority zones in order to better assess each circuit's immediate needs. In addition to vegetation encroachment data, the survey also provided critical information, including rectified tower and span locations and a detailed clearance analysis.

Following completion of the survey, DTE conducted spot checks of 200 locations to assess the accuracy of the LiDAR data. Encroachments measured in the survey were accurate to within four inches, ensuring a level of accuracy previously unavailable to the utility. The spot checks also helped DTE and Quantum Spatial identify the survey's limitations and understand how best to use the data.

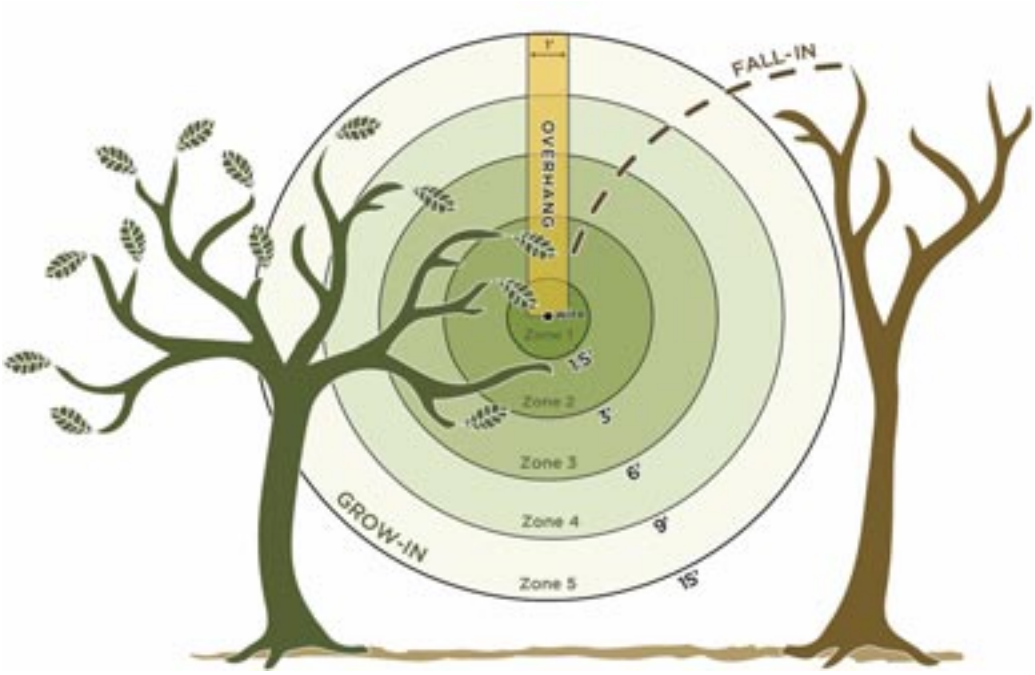
Performing a Volumetric Analysis

Though the results of the LiDAR survey were accurate when estimating encroachment to conductors, vegetative conditions in the area produced unique challenges. When producing canopy segmentation data, the survey struggled to identify codominant stems where one trunk may separate into multiple canopies.

In addition to struggling with codominant stems, DTE found that planning work based on only priority-zone threat levels did not provide sufficient context for planning the actual work required to be done for each tree canopy.

In order to provide further context, DTE turned to the Quantum Spatial's

Figure 2. Unclassified high-density LiDAR data of Detroit skyline, including iconic Ford Field and Comerica Park, had an average density of 34 ppsm with a vertical accuracy at 2 Sigma of 2.82 cm.



Overhang*: A tree is found to have a branch overhanging up to 15 ft above a wire and within half a foot on either side of the wire

Fall in*: A tree is found to have the potential to fall across the line based on proximity to wire and tree height.

Vegetation Encroachment Categories:
At the time of flight, vegetation was encroaching on a primary wire:

ZONE	DESCRIPTION
1	Within 1.5 ft
2	1.5 - 3 ft
3	3 - 6 ft
4	6 - 9 ft
5	9 - 15 ft

Figure 3 (a) (b) (c). DTE's Vegetation classified LiDAR data of vegetation encroachments into five priority zones. Zone 1 encroachments are within 1.5 feet of the wire and zone 5 encroachments are furthest away, between 9-15 feet away. The analytics identified vegetation grow-ins, overhanging the wires, as well as vegetation fall-in conditions.

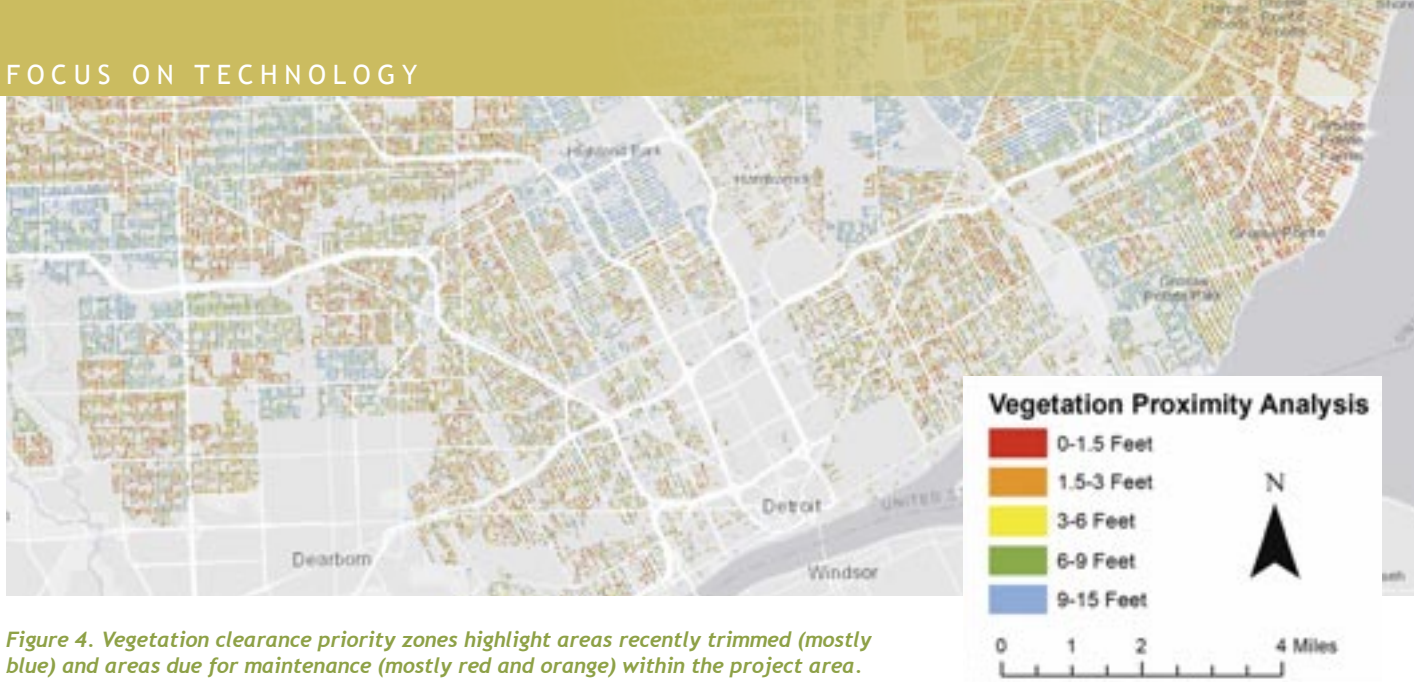


Figure 4. Vegetation clearance priority zones highlight areas recently trimmed (mostly blue) and areas due for maintenance (mostly red and orange) within the project area.

volumetric assessment to focus on severe encroachments and the volume of vegetation to be removed to per each individual zone infraction. By relying on the volumetric analysis within each priority zone, as opposed to relying strictly on a LiDAR-provided tree count, DTE was able to shift its focus to ensure it was making the most effective decisions when prioritizing assignments.

Experiencing a Paradigm Shift

Prior to LiDAR, DTE's service territory introduced a high level of uncertainty when managing bids from outside service providers. Because of the accessibility demands and scale of sensitive areas, the utility is rarely able to comprehensively inspect potential encroachments in advance of routine trimming.

The character of the region's geography encourages contractors to make opportunistic bids or forced contractors to build significant contingencies into their pricing. Due to the inherent unknowns of the situation, DTE was forced to concede higher costs.

The new trove of data available to DTE brought about a fundamental shift in the bid negotiation process. With a standardized, quantified inventory of encroachments, the utility could level the playing field among vendors and drive competitive pricing. The new data was useful for managing time and equipment (T&E) contracts, as well as negotiating fixed-bid contracts, as the LiDAR data allowed DTE to precisely quantify the work involved to each bidder.

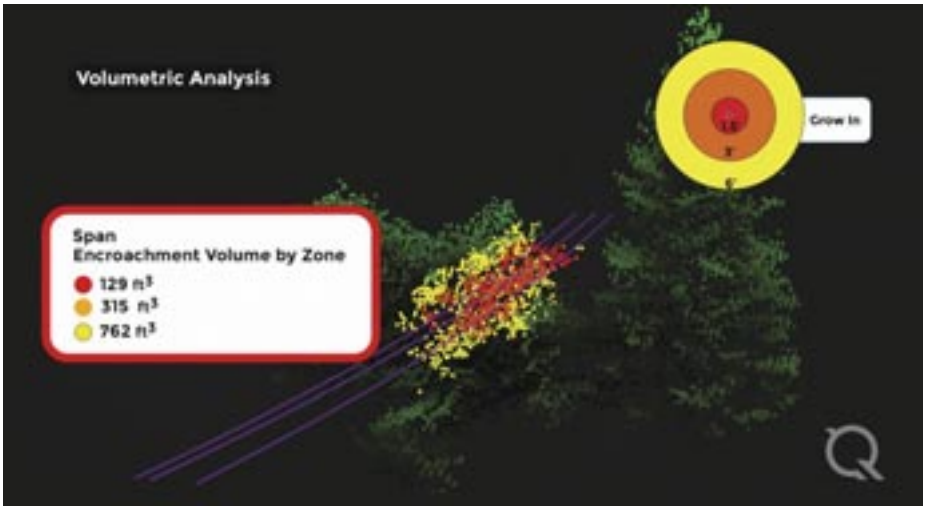


Figure 5. Red, orange, and yellow LiDAR returns designate the cubic feet of vegetation required to be removed on a single span of distribution wires. This cubic assessment assists work planning, contract negotiations, and contractor auditing.

Armed with precise data, DTE developed models to determine whether bid estimations matched the reality of the assignment. The utility trained its machine-learning algorithm, a linear regression model, by providing it with examples of circuits with known vendor bids.

As more information was provided to the model, it was then able to estimate the cost of future contractor work by drawing correlations with historical data. Most importantly, the model was able to identify outlier circuits that may be overbid, empowering DTE employees to compare the bid price with the LiDAR survey.

Using a K-means clustering algorithm, the model grouped similar circuits together based on the structure of the LiDAR data. The K-means clustering model further enhanced the conclusions of the linear regression model, emphasizing those bids that did not align with historical performance and allowing DTE to further negotiate pricing based on solid data.

Lowering the Cost of Contracts

DTE put its LiDAR data to the test in a series of bid negotiations for both expedited and general maintenance trimming. In one instance, the LiDAR pricing model predicted that the contractor line mile cost should be

just 48 percent of current prices on a T&E contract.

Using the model's estimated bid, DTE provided an actionable target line mile cost to the contractor. DTE exchanged information with the contractors regarding the LiDAR-based audit with the contractor, showing them that their current productivity was almost doubling the calculated run-rate. This conversation led to the contractor's cost falling about 30 percent.

One of the greater successes of the LiDAR program was the ability to identify an area of unexpectedly severe vegetation encroachment relative to its anticipated maintenance cycle. Using the encroachment data derived from the LiDAR, DTE was able to expedite maintenance trimming in the area. The expedited maintenance trimming request went out for a firm fixed-price bid and covered a single substation in a highly sensitive community.

The utility received multiple bids that were higher than expected. DTE used the LiDAR data to quantify true work volume for the substation and subsequently quantified the true work value of the project. The pricing model generated estimated bids for the assignment, and the expedited maintenance project saw a final price reduction of 28.6 percent, covering the entire cost of the Detroit LiDAR survey project.

Defining Bid Scope

In addition to ongoing and expedited 2019 projects, DTE applied its LiDAR survey data to its yearly contracting process for 2020. All bidders were provided with the LiDAR data results, which included a true and comprehensive assessment of the locations and amount of work that needed to be performed.

In previous years, DTE had observed an extremely high variance in bid prices between vendors and frequently received bids misaligned with the companies expected cost. The detailed LiDAR information brought contractors and DTE to a consensus, where DTE received total bid prices from all bidders—all of which were within five percent of DTE's anticipated 2020 cost.

Beginning the bid process with fundamentally accurate data and having less variance between bids provides a level playing field for contractors and DTE. This data also enables more reasonable expectations for bids from both parties moving forward.

Additionally, the utility was able to further negotiate discrepancies on an individual circuit level between the predicted price and the bid price based on the LiDAR and volumetric results, successfully driving down the final cost of the agreements further.

Shifting Toward a Condition-Based Program

In addition to the trim contracting benefits, the LiDAR data enables DTE to identify critical vegetation hotspots to proactively address the

situations that pose imminent outage threats, in turn extending the trim-cycle life of these circuits.

Furthermore, the LiDAR data enables the performance of post-trim inspection audits of areas that recently experienced routine maintenance, empowering DTE to identify areas where contractors failed to meet their trimming obligations. Multi-year LiDAR data collections over the same area further enhance this capability as well as provide additional change detection analytics, such as providing information about growth rates.

Related to the previously mentioned applications, LiDAR data also enables DTE to make a program shift from cycle-based maintenance to condition-based maintenance. Making the shift to condition-based maintenance is a topic of interest for many utilities, as prioritizing and allocating trimming to be based on threat and need instead of a somewhat arbitrary timeline is only logical.

Figure 6. Red, orange, and yellow LiDAR returns designate the cubic feet of vegetation required to be removed on a multiple spans of distribution wires. This cubic assessment assists work planning, contract negotiations, and contractor auditing.

The shift requires time, logistical planning, and changing management as it is a significant departure from how DTE, other utilities, and trim contractors operate today. Most importantly, to make the shift, utilities need to know exactly where their vegetation threats are across their system and how to prioritize the threats, which is exactly what is provided by DTE's LiDAR surveys.

Showing an ROI

Following completion of the project, DTE worked with Quantum Spatial to conduct a thorough, yet conservative, cost-benefit analysis that included data points, such as corridor

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miles, inspection frequency, average clearing cost per mile, and SAIDI and SAIFI—the average outage duration for each customer served and the average number of interruptions experienced by a customer, respectively.

The predicted ROI in the project area over a five-year cycle includes both outage reduction and trim reduction, as well as the overall optimization of inspections and trimming. The total return on investment is 10.5x DTE's initial outlay.

Since completing the original LiDAR survey in December 2018, DTE commissioned additional surveys to capture other areas of its service territory. Based on the success of the program, the utility is considering expanding the program.

Realizing Benefits Beyond ROI

The impact of DTE's LiDAR survey extended beyond financial gain. Most importantly, the increased efficiency of the utility's VM program has led to improved public relations, as an overall decrease in outages has boosted customer satisfaction. The program's deliberate targeting of vegetation has also led to a safer work environment for DTE employees and its contractors, as the targeted data allows field employees to limit the amount of time spent in sensitive neighborhoods.

In the short-term, DTE will continue to use volumetric data analytics to inform targeted trimming strategies, future vegetative growth and bid negotiation techniques. DTE also plans to explore other remote sensing technologies to monitor vegetation control in more rural areas. As the utility continues to perform cyclical LiDAR surveys over the next several years, new information will feed into its models to adapt and enhance a more comprehensive program, further honing their effectiveness.

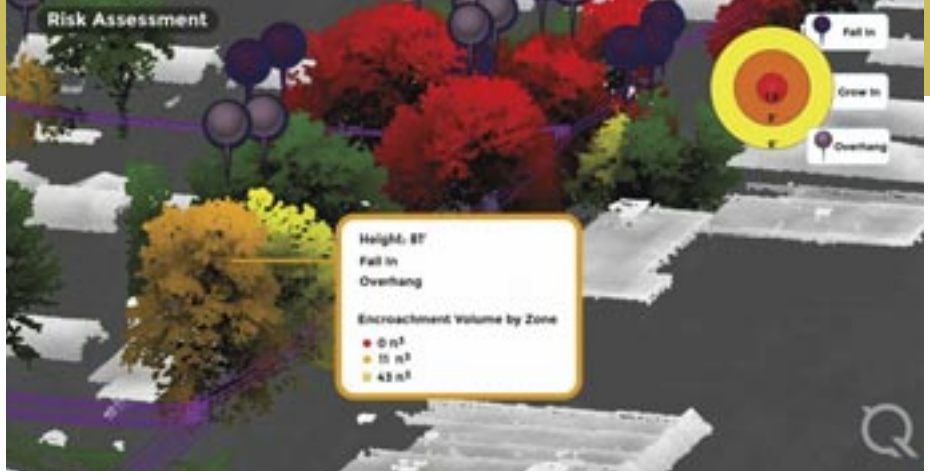

Figure 7. Red, orange, and yellow LiDAR returns designate the vegetation encroachment type, severity, and volume required to be removed per tree for multiple spans of distribution wires. This assessment assists with work planning, contract negotiations, and contractor auditing.

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Kim Coppen joined ACRT in 2015 as a consulting utility forester (CUF) after her husband, Josh, was transferred to Texas to lead a team of financial advisors. Both have environmental science degrees and never planned on working in an office environment, so when Josh saw how happy Kim was in her new career, he also joined ACRT as a CUF.

"Neither of us had industry experience, but ACRT made sure that we had the training and development opportunities we needed," the Coppens said. "Their emphasis on safety is first-rate. They prioritize it and understand that field work presents hazards not found in other occupations."

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While the Coppens don't work on the same projects, they do find time for lunch when they have assignments in the same area. Outside of work, the Coppens enjoy traveling and outdoor activities with their son, Quinn. Learn more about opportunities with ACRT Services at *careers.acrt.com*.

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