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Tree Re-use at the University of Pennsylvania: Establishing A Re-utilization Program

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                                   Establishing A Re-utilization Program

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Abstract:

An urban wood re-use program at The University of Pennsylvania is in production, with the goal of sustainably recycling trees and tree parts from Penn properties in the form of marketable wood products. My objective is to jumpstart a sustainable and adaptable wood re-utilization program on Penn's main campus and at Morris Arboretum by analyzing current practices, developing an adaptable tree removal policy, and establishing partnerships with local organizations and artisans.

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INTRODUCTION

According to a 2016 U.S. Forest Service study, Philadelphia's urban forest stores about 702,000 tons of carbon (Nowak et al., 2016). Furthermore, Philadelphia's trees remove about 27,000 tons of carbon from the atmosphere per year (valued at $3.6 million per year), remove about 513 tons of air pollution per year (valued at $19.0 million per year), and reduce annual residential energy costs by $6.9 million per year (Nowak et al., 2016). Thus, urban trees provide considerable value to the community.

Despite this value, sometimes trees must be removed or pruned. These activities may be required for a variety of reasons, including disease, safety concerns, vandalism, mechanical damage, or construction. Thousands of accessioned trees are currently a part of the University of Pennsylvania's main campus arboretum in West Philadelphia, as well as the Morris Arboretum of the University of Pennsylvania in the Chestnut Hill section of Philadelphia. Hundreds of trees are removed from these properties each year. The environmental footprint of removing these trees and tree parts impacts the overall sustainability of the University.

As human behavior continues to be marked by a culture of waste, the natural environment is an archetype of waste efficiency. In a forest ecosystem, waste products become degraded and recycled through natural processes. However, when urban trees die or need to be removed, their ability to participate in these natural forest processes is severely restricted. Converting urban tree waste into functional wood products presents an alternative method of urban forest recycling; not only by making use of the removed tree parts, but also by potentially reducing the number of new products that would have otherwise been purchased by consumers.

Currently, at University of Pennsylvania sites, removed trees and tree parts are usually mulched or used as biofuel. These are not optimal methods of recycling wood, as the carbon dioxide (CO_2) stored in the wood is almost instantly released back into the atmosphere. A 2015 U.S. Forest Service assessment found converting removed tree residue to wood products, instead of bioenergy or mulch, resulted in substantially lower net CO_2 emissions (McPherson et al., 2015). Urban trees should be put to their highest and best uses to maximize their economic, environmental, and societal benefits—even after their death.

Through a wood reutilization program, the University of Pennsylvania could save or make money through the creation of unique, marketable wood products. More importantly, such a program would allow the University to meet institution sustainability goals by closing the material loop. Most crucially, this program presents the University with the opportunity to establish a comprehensive resource management program that can be adopted by the Greater Philadelphia region—and beyond.

METHODS

Section 1: Getting Started – Data and Modeling

1.1 Will a Wood Reuse Program Work in Philadelphia?

According to Vibrant Cities Lab[1], the following community characteristics help wood reuse programs work:

1. Substantial tree canopy with a high proportion of hardwoods
2. Ready access to urban wood waste
3. Recent or consistent threats to trees (such as pests, storm damage, etc.)
4. Strong materials reuse markets, including demographics that support local and sustainable products
5. Stable partners with the vision and capacity to undertake key elements of the program
6. High costs of using or maintaining landfills

According to these guidelines, Philadelphia is a good candidate for a wood reutilization program. The city possesses substantial tree canopy made up mostly of hardwoods that undergo regular maintenance and removal. Trees in Philadelphia are removed due to reliable threats such as high wind events or emerald ash borer. Additionally, as an immense metropolitan region with strong environmental values, Philadelphia boasts reliable markets for recycled products, as well as institutional and non-profit partners that are devoted to sustainability initiatives.

1.2 Determining a baseline

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[1] See www.vibrantcitieslab.com/guide/

Before establishing a wood reuse program, current practices must be outlined. First, the institution must determine:

1. How is wood currently disposed of at the University of Pennsylvania? How many removals occur annually?
2. What is the volume and quality of wood removed?
3. Does another organization in the region also need wood disposed of? Are they interested in partnering with us?

At Morris Arboretum, processes are handled internally by the arborists who give the wood away, turn it into compost via free township services, chop it into internally used firewood, or occasionally dry it in the barn and create crafts. Wood from Morris Arboretum was once sold to a local company who sold it back to Morris Arboretum as appealing office furniture.

1.3 Modeling current use

Once initial questions are answered, the next step is to establish a more a detailed modeling of current practices. Investigations include:

1. How much money is spent annually on transportation, handling, disposal, chipping, grinding, etc.?
2. Does the campus spend money on wood products that could have been made from recycled campus trees?
3. Can the campus make wood available to organizations that are committed to building a better resource management model?

Technical modeling allows decision-makers to visually and numerically understand their urban forest. Tools such as an Environmental Decision Support System (EDSS)[2] can model and visualize important data.

1.4 Evaluating current practices

After modeling current practices, the efficiency of these processes must be evaluated. Stakeholders should aim to investigate:

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[2] See www.northropgrumman.com

1. What wood-related activities are currently working or not working on campus?
2. Does the campus or the community have wood product needs that are not being met?
3. Will Penn Facilities and Real Estate Services (FRES) support a wood reuse program on campus?
4. Will a wood re-use program help fulfill a Penn program or goal such as Penn's sustainability plan?
5. Are there any legal procedures that need to occur for this program to be introduced?

1.5 Researching Markets

After answering these questions about current practices, market research can take place. What wood markets exist on campus? In the region? What new markets could emerge? Where and in what forms could wood be sold within the University? What marketing materials already exist? Note that The Urban Wood Network[3] provides marketing and networking materials through membership.

Wood markets may already exist in the region. New markets for clean wood products should be determined in the area. Many existing recycling programs are focused on recycling pallets or construction materials, not trees. Also, many existing programs simply mulch the trees or turn them into firewood, which has a larger carbon footprint than creating functional wood products. Therefore, a need for functional wood products is likely ongoing. After baseline data is established, research needs to be conducted on who would purchase functional wood products at The University of Pennsylvania and Morris Arboretum.

Unlike rural wood harvests, each urban specimen is unique due to its environment, species, removal method, and more. This creates added complexity but is also a distinct marketable feature. In the midst of an urban wood re-utilization program in Philadelphia, establishing an online database of available specimens for local woodworkers and artisans to review could become a valuable tool.

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[3] urbanwoodnetwork.org

Wood or wood products should be sold by the University at the University of Pennsylvania bookstore, Morris Arboretum Gift Shop, alumni associations, and online. The marketing department at Morris Arboretum is equipped to develop marketing tools and tactics for such a program. Likewise, a marketing team for Penn's campus could partner with the program. Partnerships should be developed in advance along with appropriate branding.

Profit aside, the ultimate aim of this program should be to advance sustainable resource management throughout the city of Philadelphia.

Section 2: Organization and Planning

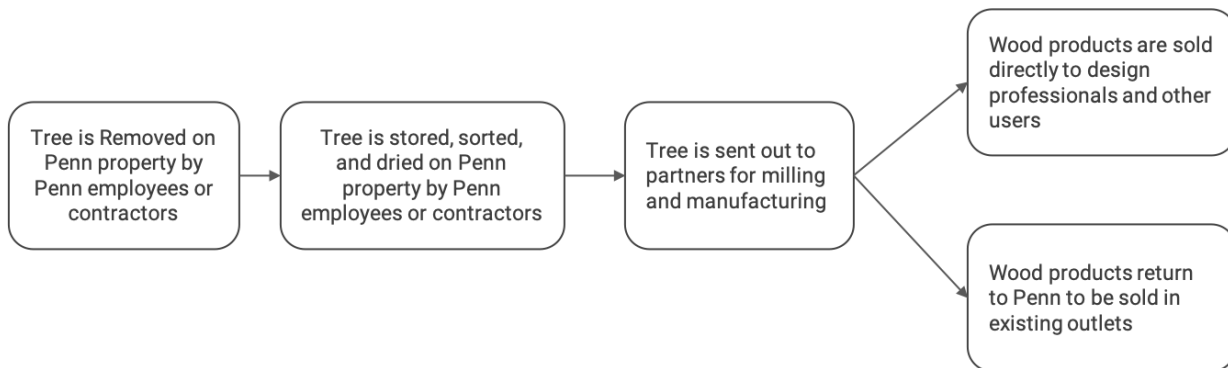2.1 Transportation, Storage, Drying, and Sorting

Figure 1 – Initial program outcomes

Urban lumber is attractive to artisans and environmentalists alike. However, transforming a tree into a useful object is not simple. Sawmills are expensive and require skilled staff, as does transportation and preparation of the wood. To simplify logistics, removal contractors should deliver wood directly to its storage location. Partnering with a local sawyer with whom profits are split can be advantageous. Sawyers and woodworkers might be intrigued by the opportunity to receive unique urban wood. Such partnerships can reduce some of the complexities of the operation.

The re-use value of a tree depends on several factors including its size, form, species, condition, quality, and accessibility. This warrants a case-by-case analysis of each removed tree or tree part.

For example, one urban tree may present ideal lumber wood but may be too inaccessible to cut as such due to the spatial constraints of the urban environment. Another urban tree may have highly knotted wood, which is not ideal for lumber but can be promising to an artist or furniture-maker. Urban trees may also exhibit unique features that present as obstacles, such as embedded hardware and vandalism. Therefore, a sorting process must be implemented to determine the fate of each individual tree.

An Urban Forest Wood Re-Use Study was published for the city of San Francisco in 2014 by a group of graduate students (Dirrenberger et al., 2014). The study recommended a system in which lumber and specialty wood products are extracted from removed trees with a focus on public engagement. The report determined: "street trees experience harsh conditions and their size and wood quality is usually low such that only an estimated 10-15% is suitable for lumber. Park trees are larger and usually of better quality such that an estimated 15-20% is suitable for lumber" (Dirrenberger et al., 2014). Similar conditions are likely to be encountered in Philadelphia.

To store, dry, and sort collected lumber, it is optimal to find a space with a level surface, access to water, and a covered area for drying. This space might be an old sawmill that is no longer operating, an underutilized industrial park, or an unused parking lot. Ideally, wood needs to air-dry out of direct sunlight for at least a year. In addition, high-temperature kiln drying can be useful, but it may cost about $.50-$.60/board foot. This rate may not be worth the investment for lower-quality boards. Vibrant Cities Lab suggests reviewing the system designed for an urban sort yard in Baltimore, MD[4].

The following factors were recommended by *The Urban Wood Toolkit*[5] to consider when sorting.
- Diameter: Logs should be at least 10-12 inches in diameter to be millable.
- Height to first branching: Typically, a log of at least 8 feet in length is desirable for milling.
- Accessibility: Can the tree be properly accessed to cut and remove it for use?

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[4] See baltimorewoodproject.org
[5] See urbanwoodnetwork.org/resources#toolkit-1

- Quality: Does the tree have damage, contain metal, etc. that would restrict use? Personnel must be able to determine wood quality.
- Species: Species will determine suitability for different products.

Emerald ash borer (EAB) is currently an insect pest in the Philadelphia area and is prompting the removal of dead and dying ash trees across the region. The City of Elkhart, Indiana successfully implemented an urban wood re-utilization program in the wake of the pest outbreak of EAB[6]. In this case, removed trees are sold for $20 per log. The logs are available to anyone who desires to use the higher-quality wood for "value-added purposes." The proceeds of wood sales fund public tree planting operations. EAB has prompted wood re-utilization awareness in several other affected cities, as described in the 2010 publication: *Using industrial clusters to build an urban wood utilization program: a twin cities case study* by Bratkovich and Fernholz. Several organizations aim to promote better utilization of urban trees claimed by EAB, and several private recycling operations are cited as EAB-focused. However, these operations are predominantly generating mulch, rather than functional wood products. Creating functional wood products from declining ash trees can be a challenge due to decay in the wood.

When re-utilizing newly removed wood, it will be transported to a storage area to be sorted for use, rather than being transported for disposal. This storage area should be a covered, level area with access to water. At Morris Arboretum this would likely be the barn, which has already been used for such purposes. On the main campus, this might take place on the Pennovation property or on a vacant lot. Alternatively, wood can be transported from Penn's campus to Morris Arboretum to be stored in the barn/storage yard and cared for by the full-time Morris Arboretum arborists.

2.2 Determining Personnel

A leader must be chosen to manage the program on both campuses. Wood reuse value depends on size, form, species, condition, quality, and accessibility. Morris Arboretum employs knowledgeable, full-time arborists who can transport, store, sort, and dry wood, if permitted. A staff member on Penn's main campus must also be knowledgeable and available to manage

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[6] see www.elkhartindiana.org

storage, sorting, and drying on main campus. Alternatively, Morris Arboretum arborists could take care of the wood on both campuses.

Section 3: Building a Framework

3.1 Establishing a Removal Policy

The aim of this project is not simply to reuse wood, but to build the policies and partnerships necessary to frame a sustainable and expandable wood re-utilization program. To jump-start a sustainable and expandable re-utilization program, Penn must develop and implement an adaptable policy for all tree removals on campus moving forward.

3.2 Building the Network

As the leader of this program in Philadelphia and a member of the Urban Wood Network, Penn will develop a sustainable network of local partners. Penn wood can be made available to local Urban Wood Network members. This network can include other institutions who also want their trees to be re-utilized. Supply chain links should connect resource managers, those who process wood from trees to finished products, and those who use the premium end products (figure 2).

Each campus location must determine what services cannot be completed in-house and will require outside partnerships. Each location must also establish customers that are interested in recovering or purchasing the available material. Existing industry services in the area should be researched, including milling, drying, and woodworking. Both parties entering into a partnership should clearly benefit from the relationship. A formal agreement should be drafted when entering into a partnership that overviews roles and responsibilities.

Morris Arboretum has already partnered with sawyers and woodworkers to produce wood products from removed trees. Other unique partners can include the Stuart Weitzman School of Design and other student groups.

Urban Wood Industry Model

Figure 2 – Urban wood industry model[7]

3.3 Exploring Product Opportunities

Re-used wood products include surfaced, kiln-dried lumber; rough, air-dried lumber (such as utility boards); burls for woodworking; firewood and fuel; mulch; animal bedding or playground cover; and compost.

Morris Arboretum currently transforms a substantial volume of wood waste into compost and firewood. There are compost facilities on University of Pennsylvania's main campus as well. Preserving more urban trees for lumber and woodworking at both locations would reduce the University's carbon footprint and create opportunities for revenue.

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[7] From urbanwoodnetwork.org/join-the-movement

Section 4: Next Steps

Figure 3 – Steps to establish a wood reutilization program

Once existing data and practices are assessed, personnel and logistics are delineated, a tree removal policy is written, and a network of partners is established, the feasibility of an urban wood re-utilization program will be clear. Currently, stakeholders are in the process of defining a particular tree and project to act as a pilot study. Meanwhile, detailed budgets, markets, and product plans can be established to jumpstart tree re-utilization on campus. With the advent of a wood re-use program, the University of Pennsylvania will actualize a strong leadership position in sustainable resource management.

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