Tracing Timber

by

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Today, the big box store is where we buy our wood, but not long ago the wood that we used for the structures, finishes and furniture for our buildings might have been harvested locally from a nearby forest or even the building site. We might have been familiar with the trees growing nearby and how they could be used in craft and construction. We may have been the ones to fell, season, mill and craft the wood into our designs. Today, this close engagement with the material is rarely the case and the full life cycle of timber is increasingly difficult to observe and understand, with trees being harvested in remote forests, wood trade occurring globally and milling and craft becoming increasingly automated. This growing separation between us and the life cycle of timber is problematic. It means we relinquish an embodied understanding of the materials we use, and the places and ways in which they grow, thrive and die. It means we cannot begin to ask questions about the relationship between the wood we craft with and the trees that we experience in our cities and forests.

This thesis is an attempt to retrace the life cycle of local wood from the forest, to the sawmill, workshop, and into our homes. It takes the form of a series of exercises, site visits and built projects which opened me to the rich world of textures, colours, and experiences within our reach in the Cambridge region. It suggests how a close engagement with timber materials throughout the education of architects might foster a renewed sense of responsibility and stewardship towards the places and natural systems in which we live and build.

Acknowledgments

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Thank you to Joe Bauman and Bauman Sawmill for opening up their doors, Ian Hodgson, and Andrew Poynter for founding one of the region's most interesting wood stores and for sharing his knowledge early on. Thank you to Heinz Koller and Dan Jessel passing on their woodworking experience.

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All images by the author except where noted.


2x8x16
2x10x16

Big Boxes, Tree Plantations and Cookie Cutters

1.1 Lumber aisle in a Cambridge big box hardware store.

We wandered the endless aisles under the cold steel roof and fluorescent tubes of the local hardware store, with its concrete floors, scratchy PA systems and orange shelves, near our home in the northern suburbs of Toronto. These visits were a weekend ritual, and we would enter with a purpose, or sometimes curiousity about the endless variety of shapes and materials for sale. You could find everything you need for your home: gardening, hardware, paint, plumbing, lighting, tools, doors, windows, bath, kitchen or lumber, with every item stacked by size and shape, named, labelled and bar coded for easy consumption. The lumber department was to the far right of the huge warehouse with its wide aisles and standardized lumber and sheets stacked up high. Plywood, MDF, chipboard, trims, dowels, and intricate mouldings filled the next aisle, all made in a few select types of wood and composite materials.

We would buy most of the wood we needed from this store, for small school projects or bigger household fixes. These visits continued throughout high school and then university. From time to time we were tasked with some model or installation that required wood products and whoever had the biggest car would fill it up with students and head to the big box store. In classes, we started to learn about how these products were used in construction, how they are sized according to forces and loads, and how they are detailed and connected to the rest of the assembly. We learned by trial and error how to saw, drill, screw, glue and finish the material.

Working in offices after undergrad, it was clear that the use of wood in architecture and construction in Canada and globally was on the rise, with changes to building codes allowing for larger and taller timber buildings, and CNC and robotic technologies allowing for the use wood in innovative and fantastic new ways.

The more I used or design with the material in school or in the workplace, the more I realized that I knew very little about where wood came from, or the many steps needed to transform it from tree to timber. As an architecture student and practitioner, did I have a responsibility to learn about the provenance and ecological impact of the material I was using? With the increasing importance of sustainable practices in architecture due to climate change, it was clear that all schools and designers had a duty to teach and learn about the materials of architecture and I started to ask questions about where these materials came from, how they were harvested and processed and how this might have affected the ecosystems which they came from.

1.2 Lumber grading stamps at the local big box. The stamps show the type of product, the quality, the species, the mill number, and any chemical or heat treatments.

To being answering some of these questions, I return to the big box stores, this time in Cambridge, to see what I can learn. I track down the first attendant I see but she works in electrical. Her voice rings over the PA system, calling a lumber specialist. He walks over and I ask him if he know where the 2x4's might be from. "Oh probably out from BC of Quebec", he says. I ask him if he has any Ontario product but he doesn't know. What species are they? I know they are 'S-P-F' but what species is this particular batch? He can't say. I look to the price tag for clues. It reads '*2x4-96' SPF Dimensional Lumber, $2.98ea, PK 1 166073, Aisle 13, Bay 001'*. I turn to the wood itself and find a small ink stamp along its length. This stamp cryptically reads *'CMSA 110, No2, KD-HT, NLGA, S-P-F'*. I'm left to wonder what these series of letters and numbers mean. I return home and quick research shows that this is called the lumber grading stamp and indicates the grading agency, the mill number, the quality or grade of the lumber, how it is treated, and finally the species of the wood.

CMSA 110	*Canadian Mill Services Association, Mill 110*
No2	*Number 2 grade*
KD-HT	*Kiln dried, heat treated*
S-P-F	*Spruce-pine-fir*


166 2
NeLMA S-GRN HT RED PINE
TECO CSA
TESTED
MILL 480
1/4" EE 708
NO.2 KD-HT
1/4" EE 708
CL A 141
NLGA S-P-F
2 KD-HT EE 1/4"
836 STUD
NLGA R 1/4
S-P-F KD-HT
836 STUD
NLGA R 1/4
A.F.P.A. 67
S-P-F NLGA 2
KD-HT
424
S-P-F KD-HT
2
888 NLGA
S-P-F KD-HT
2
240-3 NLGA
CSI. 870
NLGA S-P-F
NO.2 KD-HT
CMSA 110
No 2 KD-HT NLGA S-P-F
TECO CSA
TESTED EXTER
MILL 462
No 2
CMSA 110
CSI. STUD
133 KD-HT
NLGA S-P-F
CSI. STUD
133 KD-HT
NLGA S-P-F
S-P-F KD-HT STUD
801 NLGA R 1/4
625 NLGA
S-P-F KD-HT
STUD
625 NLGA
S-P-F KD-HT
S-P-F KD-HT STUD
780 NLGA
KD-HT STUD
475 NLGA
S-P-F KD-HT STUD
475 NLGA
CSI. 873
NLGA S-P-F
NO.3 KD-HT
APA
PR-L280
MILL 1068

Using an online directory, I trace the stamp to Mill 110 to Bear Lake, British Columbia, a small town on the Central Plateau between the Rocky Mountains and the Coast Mountains, 70 kilometres north of Prince George along the Crooked River, and owned and operated by Canada Forest Products Ltd., Canfor for short.[1]

1.3 Sawmill at Bear Lake, British Columbia.

1.4 Clear cut forests surrounding Bear Lake. The railway, road, hydro and gas corridors cut from north to south through the landscape.

Unable to travel the 4,000km from Cambridge to Bear Lake, I instead visit by satellite aerial imagery. From above, it's a small town, with a beige kidney-shaped sawmill at its centre sandwiched between a highway and a railroad, and all surrounded by seemingly endless forest. The sawmill is a complex of large grey buildings sits surrounded by piles of logs and neat stacks of cut lumber and a spur from the railway running into it. To the southeast a network of residential streets with trailers and bungalows attaches to the sawmill like a parasite. There's one gas station, a post office, a small supermarket, and a motel called the 'Grizzly Inn'. The highway follows the river north and south, and smaller roads extend in all directions into the forest. The forest is a patchy mess of shades of green and beige, seemingly random but of similar shapes and sizes, connected by the spider like roads. This is all again cut through by dead straight man-made lines, a hydro corridor, a gas pipeline, the railroad, the highway, all feeding people, electricity and commodities between the northern reaches of the province and the metropolitan centre of Vancouver.

I look for more lumber grading stamps in the big box stores around Cambridge, and again trace their locations and visit them virtually. I find twenty-four stamps; six from British Columbia, one from Alberta, four from Ontario, ten from Quebec, one from Michigan, one from New Brunswick, and one from Nova Scotia. The average distance to the School of Architecture in Cambridge, Ontario is over two thousand kilometres. The similarities between these sawmill towns are striking. The sawmills dominate the towns,

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1 CLSAB HT Facility List. <https://www.clsab.ca/wp-content/uploads/2020/01/HT_Agency_Mill_No_2020_01_13.pdf>, accessed September 2018.

with residential streets nearby, a highway, a railway, a hydro corridor, often a river, all set within a field of green and beige patches connected by snaking resource roads stretching into the distance. Each time, zooming out, I see these man-made lines and patterns extending for hundreds of kilometres into every region of country's interior. Any notion I had of Canada as a vast land of untouched forests is a myth.

1.5 Canadian sawmills traced from grading stamps and their approximate distance to Cambridge, Ontario.

As you move from province to province, you notice the difference in the shapes and patterns that result from forestry practices in different regions. In BC, the patterns are more irregular and organic, following the slopes and valleys of the terrain. As Canada's largest producer of timber products, the province is overcome with the traces of continued forestry. There are an estimated 600,000 km of resource roads, used for logging and other extraction, in British Columbia, compared to the 70,000 km of the publically maintained roads that most people use for daily travel.[2] In Alberta, the patches are more geometric and rectilinear. Here the forestry companies often share roads with oil and gas companies, whose roads and lines are more linear. Seismic survey lines, used to map underground resources, stretch over the landscape in vast grids and networks, cutting through and dividing forest in lines stretching straight for hundreds of kilometres. The patterns diminish in the prairies of Saskatchewan and Manitoba but pick up again through northern Ontario, Quebec, continuing all the way to the furthest coasts of Nova Scotia.

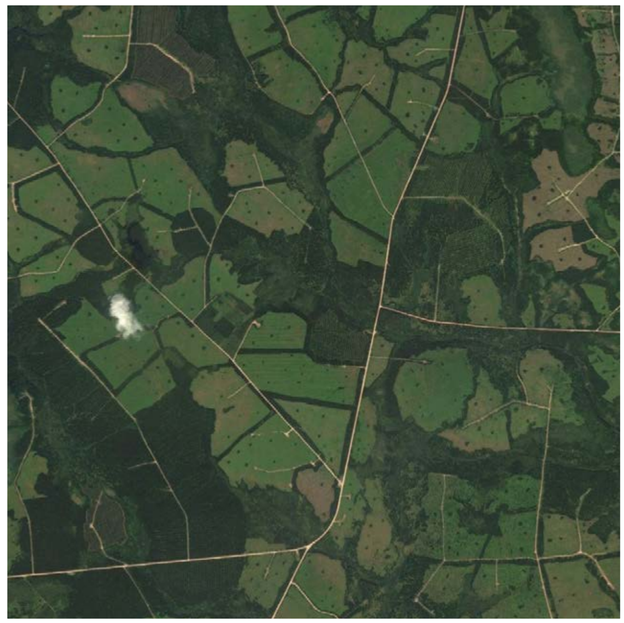
These forests, where much of our timber is harvested, are usually remote and in difficult terrain. Living in the urban centres of the country, we may never experience these places first hand, and so might not question their larger impact on ecosystems and climate. In some cases, such as in the interior of British Columbia, the clearcut sites are intentionally concealed, with policies in place preventing clear cutting on land which is visible from highways and towns. Sometimes if harvested land lies next to a road, a line of trees will

2 *British Columbia Resource Roads, <https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/resource-roads>, accessed March 2018.*

Mill No.	*Company*	*Location*	*Product*	*Distance to Cambridge*
TECO480	West Fraser	Williams Lake, BC	Softwood Plywood	4,252 km
TECO 462	West Fraser	Quesnel, BC	Douglas Fir Plywood	4,247 km
CMSA 110	Canfor Products	Bear Lake, BC	SPF Lumber	4,203 km
CMSA 110	Canfor Products	Bear Lake, BC	SPF Lumber	4,203 km
AFPA 67	Canfor Products	Grande Prairie, AB	SPF Lumber	3,842 km
APA 544	Canoe FP Ltd	Canoe, BC	SPF Plywood	3,819 km
APA 1066	LP Building Products	Golden, BC	SPF LVL	3,580 km
CSI 133	Eacom Timber	Ear Falls, ON	SPF Lumber	2,000 km
MLB 152	Williams Brothers	Barney's River, NS	SPF Lumber (Green)	1,870 km
CLA 141	Resolute FP	Thunder Bay, ON	SPF Lumber	1,455 km
QFIC 601	GDS Valoribois inc.	Matane, QC	SPF Lumber	1,262 km
MLB 708	JD Irving	St. Leonard, NB	SPF Lumber	1,209 km
QFIC 780	Lebel (2004) Inc.	Price, QC	SPF Lumber	1,207 km
QFIC 240-3	Résolu FP	La Doré, QC	SPF Lumber	1,088 km
QFIC 888	Résolu FP	La Tuque, QC	SPF Lumber	872 km
QFIC 836	Résolu FP	Senneterre, QC	SPF Lumber	858 km
APA 424	Norbord Inc	La Sarre, QC	SPF OSB	756 km
CSI 870	Eacom Inc	Timmins, ON	SPF Lumber	746 km
APA 1020	Goodfellow Inc.	Louiseville, QC	SPF Glulam	724 km
CIFQ 804	Groupe Crête	Lac-Carré, QC	SPF Lumber	638 km
CSI 873	Eacom Timber	Elk Lake, ON	SPF Lumber	622 km
QFIC 625	Résolu FP	Maniwaki, QC	SPF Lumber	600 km
OLMA 437	Ryam Bois d'Oeuvre	Béarn, QC	SPF Lumber	551 km
NELMA 166	Biewer Sawmill	McBain, MI	Red Pine Lumber	528 km

Canada's forested landscapes

1.6 Irregular clearcut patches in the Cariboo region of British Columbia.
1.7 Forestry and the oil and gas industry share land and resources near Fox Creek, Alberta.
1.8 Clearcutting in Ontario near Timmins.
1.9 Dots of trees remain as starter sites in clearcut land on Cape Breton Island, Nova Scotia.

remain next to the road, creating a facade of trees, and an illusion of endless forests for passerbys. This desire to conceal the forestry activities might be seen positively, helping to preserve the perceived beauty of the landscape. And yet this concealment and the remote nature of these forestry systems means that we might have very little exposure to these industries. How can we begin to ask questions about where our timber comes from if we don't even see these systems in action?

This concealment extends to how many of our houses are built. Our family home was one of the first homes in the new subdivision north of Toronto in the early 1990's, on what was up until then farmland, and before that most likely forest. We would visit the house as it was being built, watching the workers erect the 2x4 SPF for the walls, composite members for the beams and headers, and oriented strand board for sheathing. This wood structure was very quickly hidden as it was clad in brick on the outside, and drywall on the inside, with the underlying wood structure now only visible in the basement and attic. These light frame wood houses need to be cladded and drywalled. If the softwood is exposed to weather, it will quickly rot and degrade, compromising the house's structure. It also means that anyone growing up in the house might not question the relationship between their own house and the forests where the wood grows. Growing up in this house, I never considered what these materials were, how there harvest might have affected the ecosystems where they came from, and what responsibility I might have as someone who used them.

After five years of architecture school, and another three years in the profession, I had little understanding of the nuances of wood, the ways in which it grows, is harvested, and milled into the materials we use, and the impact of these processes on other organisms and ecosystems. I found myself specifying materials and products with little tactile or visceral understanding of the wood or the places where it comes from. I could draw no connections between the materials that we used and the trees and forests that I saw in my neighbourhood or in local forests. I realized this was not something I could learn in the big box store, surveying forests online, or in the attic or basement.

I decided to trace out these connections locally, using Cambridge as a base to engage and learn about larger cycles of timber use.

Walking

2.1 Path and pine trees in Dumfries Conservation Area, Cambridge.

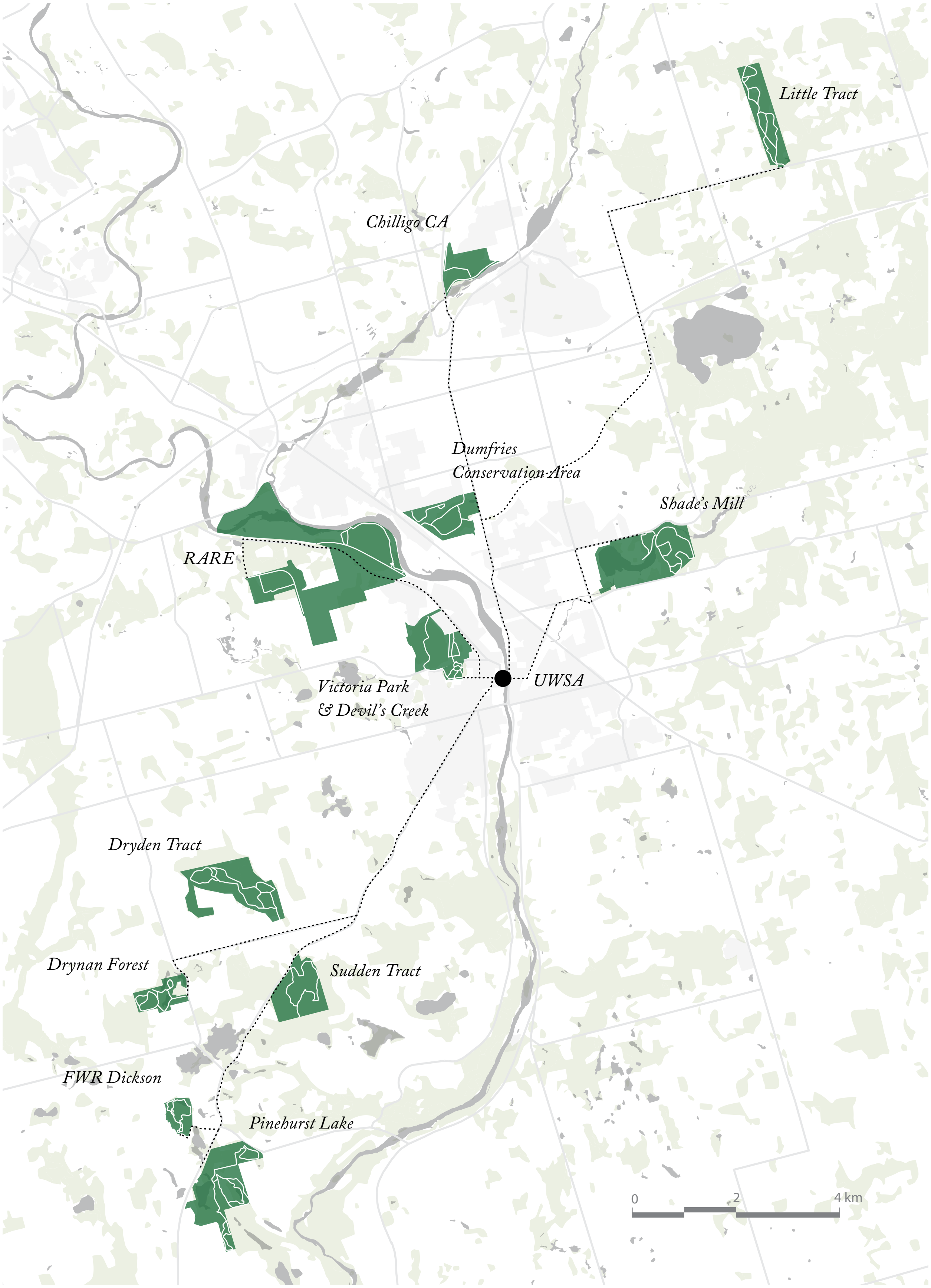
With the School of Architecture as starting point for exploration, I started walking and observing tree life around me. Without any formal knowledge, I wanted to see might be learned by just observing or experiencing trees and forests with all of the senses. Unlike the suburban streets of my youth, with their municipally planted uniform trees, the older streets in Cambridge had trees with a variety of shapes, colours and textures. Each seemed to have a unique character with some stout and hardy with sharp needles, and others more elegant with soft leaves. I started to notice the differences in the shape and colour of leaves, the colouring of the bark, and the type of shade that each tree provided. These trees were not for harvest, but they were invaluable in their own way, providing shade, beauty, animation and habitats and food for the squirrels, birds and insects. I noticed the street names: Forest Road, Alderwood Crescent, White Oak Drive, Cedar Street and many more. Venturing further, I quickly found small woodlots or forests to explore, either within walking distance of the school, or a short bike or car ride away. As I walked I took notes and stopped to observe, touch, and listen.

I visited the many woods and forests in and around Cambridge, most of which were public land. Each forest seemed to have a unique character and atmosphere with light, colours and sounds constantly changing as I walked. I started to notice the differences between trees, and also between the places where they grew. Some seemed to grow higher up on hill slopes with wide spaces between them and little undergrowth. Some grew lower down, along the edges of rivers and lakes, or in swampy lands. Each tree was different than the next, growing in relation to its neighbours, sunlight, wind, soil, elevation and much else. There were intriguing spatial and architectural conditions. Some forests were cathedral like, dominated by tall columnar trees creating vaulted canopies which filtered in the sunlight. Others were gloomy, dense with thick dark branches and eerie sounds emanating from them.

The transformations that occured constantly over minutes, hours, or days, also created a strong awareness of the passage of time in the forest. The birds, insects and other creatures would become active at different times, fungi would grow in a matter of hours and be gone the next day. Stormy weather might send trees swaying and creaking, and then within a few hours the sun would come out and begin to dry out the wet leaves. The colours of the forests and leaves changed as the seasons moved, from light browns and dull greens in the winter, flashes of colour in the spring, and vibrant greens in the summer. The shapes of the branches, buds a leaves were also in constant transformation, growing into complex forms or decaying over the months.

2.2 Map of publically accessible forest areas in and around Cambridge with the School of Architecture at the centre.

All of these sensory experiences and changes felt novel at first and foreign in many ways. I felt like a visitor or intruder entering the home of other creatures who I could not communicate with. There was a sense of unknown and even fear at not being in control or having an real understanding of this place. I noted these feelings and observations in a series of journal entries, some of which are presented in the following pages.


Little Tract
Chilligo CA
Dumfries
Conservation Area
Shade's Mill
RARE
UWSA
Victoria Park
& Devil's Creek
Dryden Tract
Drynan Forest
Sudden Tract
FWR Dickson
Pinehurst Lake
0
2
4 km

Little Tract

6710 Wellington County Road
January 31st, 2018

There is a muddy car park on the side of the road and covered sign board with some neighbourhood ads. A sunny winter day for a walk and the air is fresh. Long shadows of the trees on the snow from the afternoon sun. Without their leaves, the trees looked dead, except for the evergreens, which seemed to be alive but worn out. The rest is a tangle of branches and trunks angling through the snow and air. Everything is calm, quiet and still.

I just slipped and almost skated down the hill. The entire path has a layer of ice below, covered by an inch or two of snow. It seems a bit dangerous. Two ladies holding coffee come past and pay no attention to the ice!

The trees are dense with a lot of undergrowth. There's a path which leads off the main trail. The trees here are darker and eerie. I think they are pines. The needles are soft and thin and very green, with solid and dark trunks. Frozen sap sticks to the side of the tree trunks. They are lined up in straight rows and oppressive looking, blocking out the sun. I see some deer tracks and another set of very small feet. This path ends near a farm house. I keep slipping and I'm a little on edge. I think I'll head back.

2.3 Snow cover in Little Tract. The bare trunks and branches are stark against the white ground and sky.

Indian Woods

58 Langdon Drive
February 14th, 2018

Maple Lane trail starts at the side of Langdon Drive. There is a small sign, a gate, and footprints of humans and dogs. A grove of tall thin trees sits to one side of the entrance, densely packed together like match sticks, with stringy grey bark. Their leaves create a tight canopy over the start of the path. Some barking echoes from the distance, but all else is quiet and still.

The trail heads into a forest of evenly planted trees, spaced a few metres apart in long straight rows. Their branches radiate off the trunks in clusters, with few needles at the bottom levels, but many more above facing the sun. Some of the needles are orange and brown or fallen on the ground. There is a sound of a slow drip of water as the ice melts off of a tree. The trees are encased in a thin layer of ice but this is melting too in spots. Small chipmunks screech. One is sitting on a rock gnawing away at a nut.

The path winds through the plantation into a more natural looking forest. These are not coniferous trees. This must be Indian Woods, the old growth forest. Huge fallen trunks are strewn about. One sits at the base of this hill, over a metre in diameter and maybe twenty metres long. It's covered in a foot of snow and looks like a wall in the landscape.

A lady and a dog just passed. I asked her if this is Indian Woods. She said she has been coming here for years but doesn't know what it's called. The path continues past the forest and into farm land, with a big field on one side, and a quarry on the other.

2.4 Snow covered bark in Indian Woods, RARE Charitable Reserve.

Sudden Tract

1841 Spragues Road
May 3rd, 2018

It's raining today and the sky is grey and misty. The ground is damp and muddy and covered in wet leaves, maybe from last fall. Pine cones are decomposing everywhere. The moss is fresh and small flecks of green are budding from the tips of branches.

There's a long and sustained shrill in the distance. The first is a deep note, and then another responds but with a higher pitch. Maybe toads? There are vase like plants springing up in the marsh. I reach the boardwalk and it's solid and weathered to a dirty brown grey, darkened by the rain. It's really slippery. I can see the old boardwalk underneath the new one. Looks like the build right on top. Halfway down there's a lookout area jutting out, but it is in total disrepair, rotted and falling to the ground, decayed and aging. Probably dangerous.

The sounds here are intense. Birds are calling from every direction in so many different voices. I feel a bit like a stranger, like this is their home and not mine. I'm more of a visitor here, and maybe unwelcome. I can still here the whoosh of cars in the distance. It's a weird contrast. The boardwalk ends and the path leads upwards into a hardwood forest with tall noble looking trees.

2.5 Boardwalk zig-zagging through Sudden Tract.

Dumfries Conservation Area

Dunbar Road and Hespeler Road
May 14th, 2018

Theres a tree planting event at Dumfries. I've driven by this place hundreds of times along Hespeler but have never gone in. Sixty or seventy people are here, many families with children, some teenagers and some adult groups. The coordinators have left piles of small trees and saplings to be planted. They show us what to do and give us a shovel. I finish four trees in about half an hour and soon they are all planted, a hundred or so trees of different local species. Walking around you can see the growing trees which were planted years back.

I take a walk into the surrounding forest and find it quiet with only a few others walking. There is a large plantation of spruce trees in neat rows with the floor littered in needles and piles of large cones. There are no other types of trees growing with the spruces! Not even one. Sitting in the midst of this it hardly feels like only a few hundred metres from Hespeler Road. It's green, beautiful and calm in every direction. I'm happy I planted the trees. I see a building appear at the end of a trail. I exit and find myself in the YMCA parking lot back in the concrete jungle.

2.6 A vibrant deciduous tree with new spring leaves in the midst of tall pines and spruces in Dumfries Conservation Area.

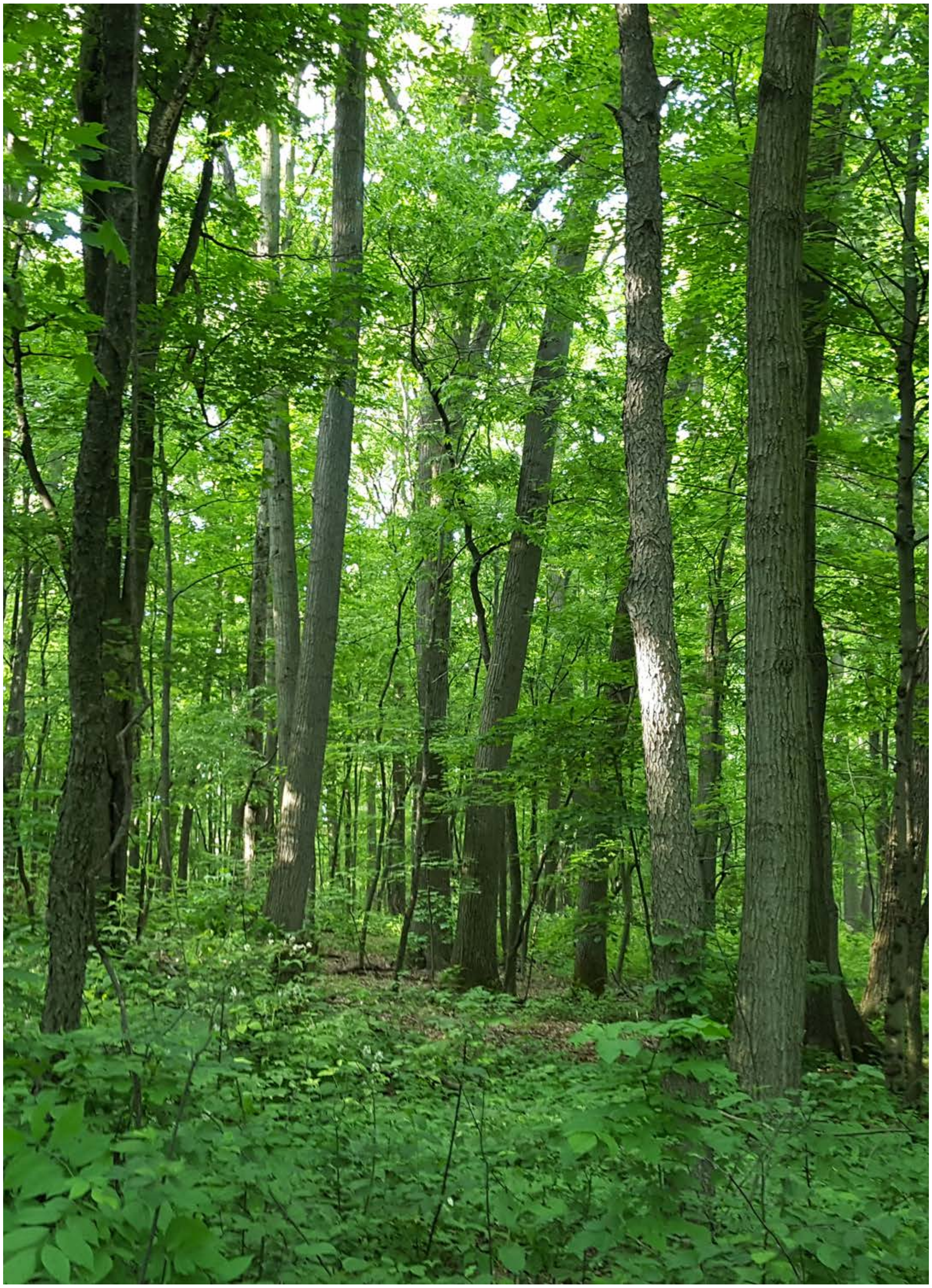
Victoria Park Woodlot

Forest Road and Salisbury Avenue
July 23rd, 2018

Everything is bright green and the mosquitoes are whirring. I came here in the winter and didn't know what these trees were, but now in the summer I see they are massive red oaks. Smaller maples and dogwood seem to be growing in the undergrowth.

One oak has fallen recently and I can smell the tannins of the tree, like walking into a wine cellar. The tree had been cut by city foresters into four foot sections, and they left it next to the path. I count 110 rings on the largest section. Its just under a metre in diameter. Close by another log is decomposing, overgrown with moss and small plants, dotted with insect holes. The leaves of the oak are waxy and deep green. The ground is covered in these pointed leaves, many brown and disintegration. I didn't notice how many oak trees there were and how old they are. The entire site is covered in them. Their canopies are high above all the other trees, many stories in the air.

The forest is alive with activity. I can hear calls from the canopy and some birds shuffle in the undergrowth. Squirrels scurry back and forth. Mosquitoes and flies are thick in the air. I want to get out as quickly as possible. This place was nice in the spring but its a bit of a nightmare now. I didn't prepare for the insects. They're following me and landing in my hair as I walk. The trees are beautiful right now.



2.7 Mature red oaks growing in Victoria Park. Maples and other species grow in the undergrowth.

FWR Dickson

699 Brant-Waterloo Road
August 4th, 2018

The site is 'closed to public'. A metal gate bars the entry to cars so I park on the road outside. The site is small, with marshes, a hill and a pond and mature trees. There's a new built boardwalk running for about a hundred metres through the marsh land. It looks like western red cedar from BC. The woodland is badly maintained and fallen trees and branches crisscross the path. I wonder how long this place has been closed? It looks similar to a forest after a ice or wind storm.

There's a huge trailer park right next to the site, with satellite antennas sticking up everywhere. Do these people use the forest? I sit on a memorial bench and watch the pond. A few insects and there are some distant bird calls but not much else. Every once in a while I can hear the engine breaks of a tractor trailer on the main road a few hundred metres away. I walk a bit further and there are charred logs everywhere. You can't smell anything, but it looks like this happened recently. I wonder if this was natural?

I search this online at home and read that this was a prescribed burn. It happened earlier in the year. They wanted to burn out the invasive species and woody trees, leaving space for native grasses to grow.

2.8 Burnt logs laying in FWR Dickson.


80


81

80, 81. Beech.


82


83

82, 83. Swamp White Oak.

84. Red Oak Flowers.


85


86

85, 86. Chestnut Oak.

28

(Leaves one-half; others natural size).


87

8


92

(Leave

Learning

We can feel and sense our way through the world, and we can also learn systematically by collecting, ordering, and naming. As I walked the forests, I started to wonder what the names of trees were, how they were related to each other, and also to other living creatures and forest systems. I felt the first step was to train myself to recognize pine, cedar, oak, maple and all of the other trees that we used as architects. I wanted to know if these grew locally. A tree guidebook, *The Forest Trees of Ontario* by J.H White, was useful in teaching myself to recognize and name the many local species. With practice, I grew confident in differentiating them by there shape, bark, leaves, colours, and textures.

In architecture, we use the common names of many tree species, and even call multiple species by the same name. Trees have common names which we use in every day conversation, can also vary from region to region. For example, eastern white cedar may also be called arborvitae, eastern thuja, or northern white cedar depending on where you are from. Indigenous people who lived in the region will also have their own names for the trees such as the Ojiwba word for cedar, *gijik*.[1] In woodworking and architecture, the common names might again be different, with many species being grouped into common types. S-P-F, is sold as one material because of the similarities of its three species, spruce, pine and fir. In Western Canada provinces such as British Columbia and Alberta, the actual species might be any of Engelmann spruce, white spruce, lodgepole pine, and alpine fir. In Eastern Canada, including Ontario, S-P-F species change to red spruce, black spruce, jack pine, and balsam fir.[2]

3.1 Tree identification pages from Forest Trees of Ontario by JH White.

Similar issues exist with hardwood species. For example maple is often divided into 'soft' of 'hard' maple. Hard maple almost always refers to sugar maple in

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1 *Peter Kelly and Doug Larson, The Last Stand, 32.*

2 *Canada Wood SPF Products. <https://canadawood.org/products/spf>, accessed March 2018.*

Ontario, the tree which provides the sought after maple syrup in early spring. Soft maple might refer red maple, silver maple, and Manitoba maple, also known as box elder. Similarly, what is sold as red oak may be a number of species including pin oak, black oak and a number of other species. White oak might consist of bur oak, English oak and many others. Although most of these oak species do not grow in Southern Ontario, hard wood that is imported is not sold with its specific species name. The properties of these sister species are so similar that they are grouped and sold under umbrella names like white oak or red oak.[3]

3.2 Samaras of a maple tree at Dumfries Conservation Area. The samaras, or 'helicopters', spin to the ground in autumn, dispersing on the wind away from the parent tree.

A more scientific way of naming a tree is to use its binomial name. Binomial nomenclature is a two-name system attributed to Carl Linnaeus, an 18th century polymath. In his 1753 encyclopedia, *Species Plantarum,* he described over hundreds of species giving them binomial names in an early form of taxonomic classification.[4] These names, such as *Homo sapien*, include the first name, *Homo*, denoting the genus, a grouping of species. The second name, *sapien*, identifies the particular species within the genus. As an example, the eastern white cedar with its many common names, has only one binomial name: *Thuja occidentalis*. It belongs to the *Thuja* genus, which may have many other species within it, and is specified with the name *occidentalis*.[5] This system is used by scientists and researchers worldwide to prevent confusion in naming.

To identify and name a tree, you might use any of a number of known characteristics of the species, such as its general shape, the shape of twigs and buds, branching patterns, leaf shapes, bark, and reproductive bodies such as cones, nuts, fruits, and samaras. Using a combination of these identifiers can lead to a more accurate identification.

3 Bruce Hoadly, Understanding Wood, 258.
4 Carl Linnaeus, Species Plantarum.
5 Peter Kelly and Doug Larson, The Last Stand, 33.

Shape
The shape of a tree is defined by its morphology and by the conditions of the site on which it grows. Trees within the same species often have unique silhouettes against the sky, or a particular shape which they tend towards. Children often draw a tree as a stick emerging from the ground, with a cloud like shape for the canopy. In some cases this can be close to the truth, as in an oak tree, but trees can also be more conical, cylindrical, vase-like or a number of other shapes. This shape is influenced by the trees surroundings and neighbouring trees. For example, in an open field, where light is all around, the tree can grow outwards in all directions, but in a forest, the same tree might need to grow upwards quickly to reach the sunlight at the canopy before spreading outwards.

3.3 Tree barks with their varying textures and colours. Clockwise from top right: black willow, black cherry, eastern white cedar, and white birch.

Twigs and Buds
The shape of buds and branching patterns can help identify some groups of trees species, especially in winter when the leaves are not present. Maples, ashes, dogwoods, and horse chestnuts will have an opposite branching pattern, meaning that two branches will grow from the same spot on a parent branch and shoot out in opposite directions. Many other types of trees, such as oaks, birches and elms will have an alternate pattern, where one bud develops on a point on the branch and another bud develops further up the branch on the opposite side and so on.

Cones, Nuts, Fruits, and Samaras
Seeds of all types are a reliable way to tell apart species. Most angiosperms are deciduous flowering trees which produce seeds in ovaries, often encased in a fruit, such as walnuts, acorns, apples, berries, and fruit trees. Trees which produce cones are called gymnosperms, also called coniferous trees, such as spruce, pine, fir and cedar. The purpose of the seed is to help propagate the next generation of trees. They usually develop in spring and into late summer, before dispersing by falling to the ground, being eaten by animals, or on the wind.




Bark

Tree bark is similar to our skin, helping to protect the interior of the tree from the outside environment. The visible part of the bark is called the rhytidome and consists of dead cells which accumulate as the tree grows. This layer protects the tree from insects and mammals and in some cases fire, fungal infections and bacteria. The bark is also very useful to humans and other creatures. The bark of birch trees has been used to skin canoes by the indigenous peoples of North America including those in Southwestern Ontario.[6]

Leaves and Needles

Leaves and needles are one of the most recognizable characteristics of a tree. Leaves are the primary locations of photosynthesis, using chlorophyll to convert the sun's energy and carbon dioxide into sugars and polysaccharides for energy. Clorophyll absorbs only blue and red parts of the light spectrum and reflects green light, giving leaves their distinctive colour. The shape of the leaf is the result of a number of factors, including the amount of sunlight available, daytime and evening temperatures, and the location of the leaf on the tree. Leaves higher up in the tree often have larger lobes or cuts in their shapes, allowing more sun to pass down to leaves lower in the canopy. These lobes also help wind to pass through the leaf without tearing it from the tree. The shape of the leaf also affects the movement of air at the surface of the leaf, an important factor in transpiration, the movement of water from the roots of the tree, upwards and out through pores in the leaf.[7]

The adoption of the maple leaf as the Canadian national symbol points towards some strong cultural and symbolic affinity for trees in this country. This was not always the case, and only on February 15, 1965 was the current flag adopted superceding the Canadian Red Ensign. This was a symbolic break from British rule, creating a distinct identity for Canada based on a leaf. The design of flag, sketched by historian George F. Stanley, was based on a long standing

6 *Edwin Tappan Adney and Howard I. Chapelle, The Bark and Skin Boats of North America, 132.*

7 *Andrew Hirons and Peter A. Thomas, Applied Tree Biology, 78.*

1	*White Spruce*	*Picea glauca*
2	*Black Spruce*	*Picea mariana*
3	*Balsam Fir*	*Abies balsamea*
4	*Tamarack*	*Larix laricina*
5	*Eastern Hemlock*	*Tsuga canadensis*
6	*Red Pine*	*Pinus rubra*
7	*White Pine*	*Pinus strobus*
8	*Jack Pine*	*Pinus banksiana*
9	*Eastern White Cedar*	*Thuja occidentalis*
10	*Eastern Redcedar*	*Juniperus virginiana*
11	*American Sycamore*	*Platanus occidentalis*
12	*White Ash*	*Fraxinus americana*
13	*Black Ash*	*Fraxinus nigra*
14	*White Birch*	*Betula papyrifera*
15	*Yellow Birch*	*Betula alleghaniensis*
16	*Shagbark Hickory*	*Carya ovata*
17	*Bitternut Hickory*	*Carya cordiformis*
18	*Black Walnut*	*Juglans nigra*
19	*Butternut (White Walnut)*	*Juglans cinerea*
20	*American Chestnut**	*Castanea dentata*
21	*American Beech*	*Fagus grandifolia*
22	*White Oak*	*Quercus alba*
23	*Red Oak*	*Quercus rubra*
24	*Bur Oak*	*Quercus macrocarpa*
25	*Black Oak*	*Quercus velutina*
26	*Trembling Aspen*	*Populus tremuloides*
27	*Bigtooth Aspen*	*Populus grandidentata*
28	*Eastern Cottonwood*	*Populus deltoides*
29	*Balsam Poplar*	*Populus balsamifera*
30	*Black Willow*	*Salix nigra*
31	*Red Maple*	*Acer rubra*
32	*Sugar Maple*	*Acer saccharum*
33	*Silver Maple*	*Acer saccharinum*
34	*Manitoba Maple*	*Acer negundo*
35	*Honey Locust*	*Gleditsia triacanthos*
36	*Black Cherry*	*Prunus serotina*
37	*American Elm*	*Ulmus americana*
38	*Basswood*	*Tilia americana*
39	*Sassafras*	*Sassafras albidum*
40	*Tulip Tree*	*Liriodendron Tulipifera*

** Endangered species*

3.4 List of tree species found in Ontario. Linda Kershaw, Trees of Ontario.

3.5 Overleaf: 40 leaf shapes of trees native to Ontario.


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tradition of using the maple leaf as a symbol of the Canadian territories. Even with this tradition, the Red Ensign was not given up easily and the new flag was only passed after a year of debate and a special flag committee.[8]

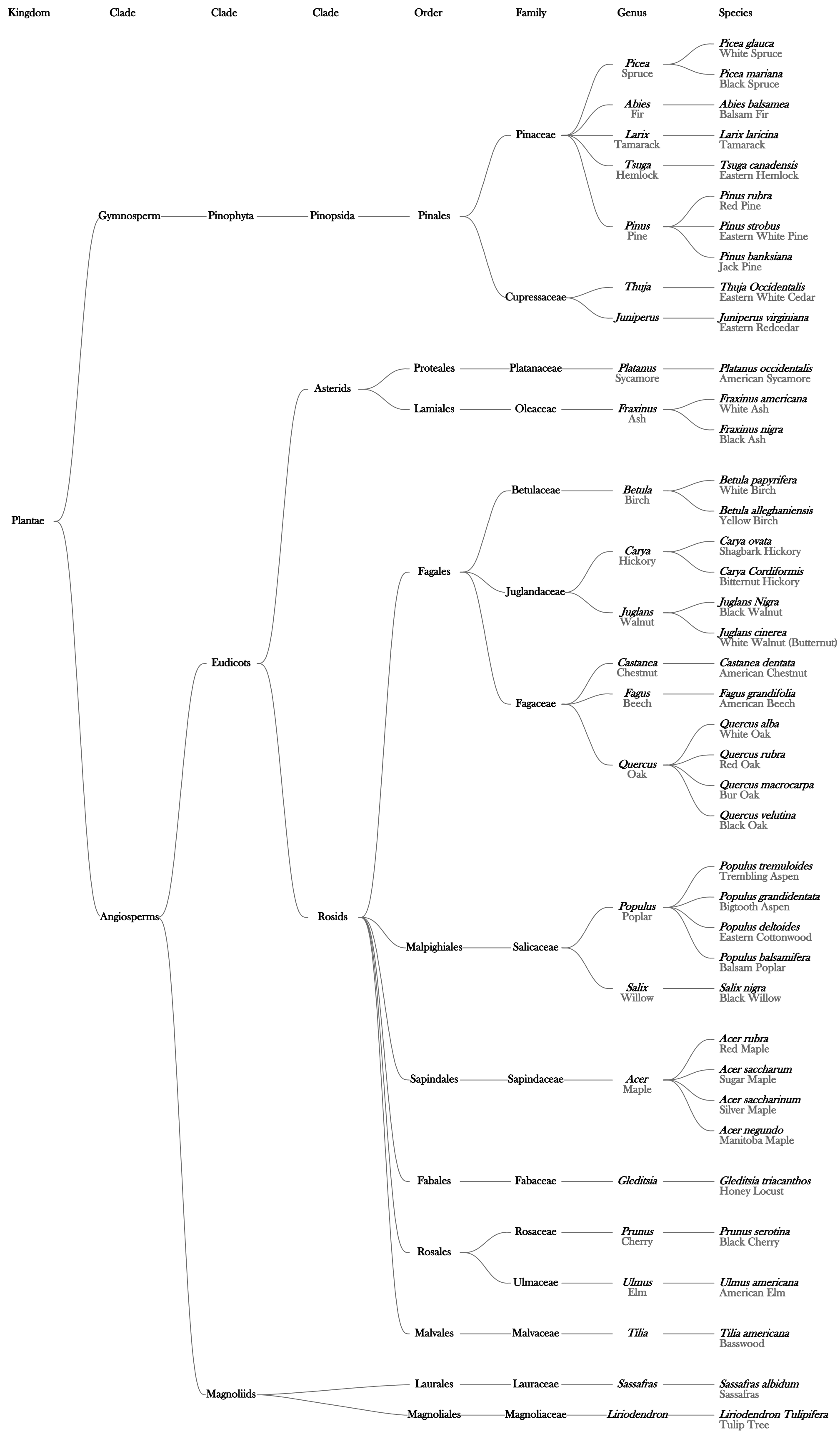
3.6 A phylogenetic tree of prominent local tree species.

Phylogenetics

Trees species, like all other organisms, can be studied and classified based on their connections and similarities. Today this is done using DNA, the unique genetic code of species, but was historically done using the morphology of the organism. These similarities are then used to create a hypothesis about the evolutionary history of the species and how they might be related or diverge. This is usually arranged into a phylogenetic tree, showing the ancestry and relationships between species. The tree starts broadly, moving from the highest classification Domain, to Kingdom, through series of Clades, to Family, Genus and Species.[9] These relationships help to explain some of the visible differences in the tree types. For example walnut trees and hickory trees both have large seeds encased in shells. They share a very close relationship, grouped in the same family of Juglandaceae. This phylogenetic tree also relates species that are in different parts of the world, which share a common lineage, but have diverged at some point and do not exist in the same regions.

8 Phillip Buckner. Canada and the End of Empire, 236.

9 Guillaume Lecointreand Hervé Le Guyader, The Tree of Life.

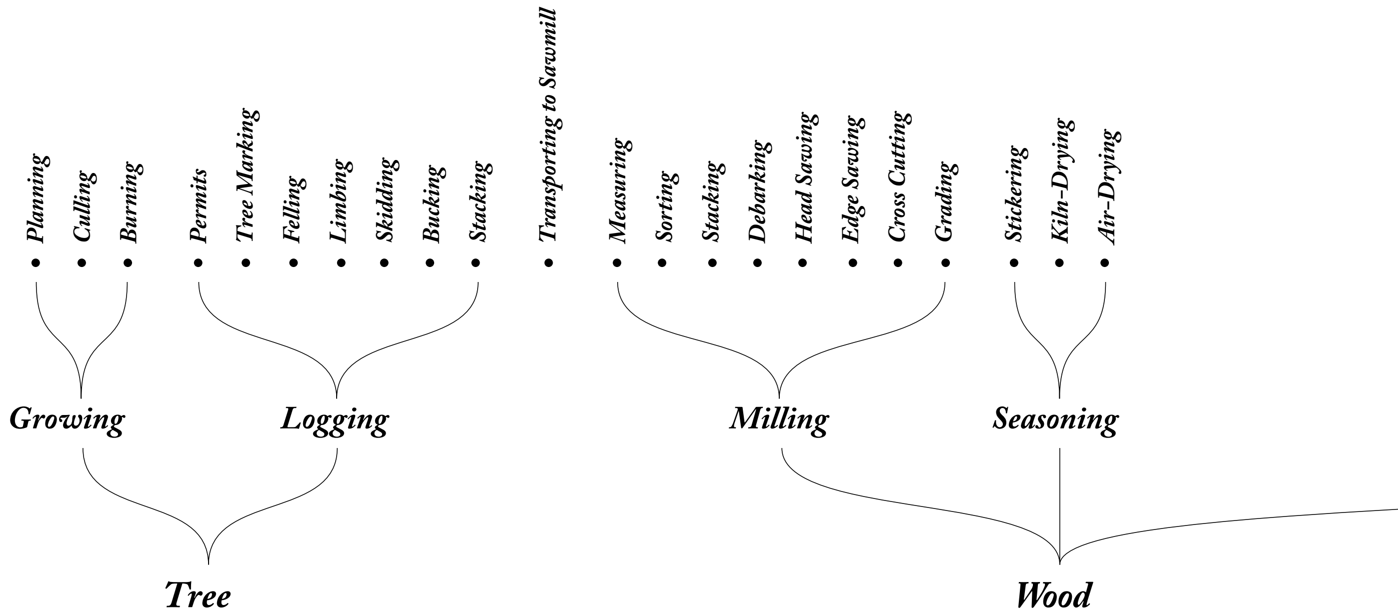

Kingdom
Clade
Clade
Clade
Order
Family
Genus
Species
Plantae
Gymnosperm
Pinophyta
Pinopsida
Pinales
Pinaceae
Picea
Spruce
Picea glauca
White Spruce
Picea mariana
Black Spruce
Abies
Fir
Abies balsamea
Balsam Fir
Larix
Tamarack
Larix laricina
Tamarack
Tsuga
Hemlock
Tsuga canadensis
Eastern Hemlock
Pinus
Pine
Pinus rubra
Red Pine
Pinus strobus
Eastern White Pine
Pinus banksiana
Jack Pine
Cupressaceae
Thuja
Thuja Occidentalis
Eastern White Cedar
Juniperus
Juniperus virginiana
Eastern Redcedar
Angiosperms
Eudicots
Asterids
Proteales
Platanaceae
Platanus
Sycamore
Platanus occidentalis
American Sycamore
Lamiales
Oleaceae
Fraxinus
Ash
Fraxinus americana
White Ash
Fraxinus nigra
Black Ash
Rosids
Fagales
Betulaceae
Betula
Birch
Betula papyrifera
White Birch
Betula alleghaniensis
Yellow Birch
Juglandaceae
Carya
Hickory
Carya ovata
Shagbark Hickory
Carya Cordiformis
Bitternut Hickory
Juglans
Walnut
Juglans Nigra
Black Walnut
Juglans cinerea
White Walnut (Butternut)
Fagaceae
Castanea
Chestnut
Castanea dentata
American Chestnut
Fagus
Beech
Fagus grandifolia
American Beech
Quercus
Oak
Quercus alba
White Oak
Quercus rubra
Red Oak
Quercus macrocarpa
Bur Oak
Quercus velutina
Black Oak
Malpighiales
Salicaceae
Populus
Poplar
Populus tremuloides
Trembling Aspen
Populus grandidentata
Bigtooth Aspen
Populus deltoides
Eastern Cottonwood
Populus balsamifera
Balsam Poplar
Salix
Willow
Salix nigra
Black Willow
Sapindales
Sapindaceae
Acer
Maple
Acer rubra
Red Maple
Acer saccharum
Sugar Maple
Acer saccharinum
Silver Maple
Acer negundo
Manitoba Maple
Fabales
Fabaceae
Gleditsia
Gleditsia triacanthos
Honey Locust
Rosales
Rosaceae
Prunus
Cherry
Prunus serotina
Black Cherry
Ulmaceae
Ulmus
Elm
Ulmus americana
American Elm
Malvales
Malvaceae
Tilia
Tilia americana
Basswood
Magnoliids
Laurales
Lauraceae
Sassafras
Sassafras albidum
Sassafras
Magnoliales
Magnoliaceae
Liriodendron
Liriodendron Tulipifera
Tulip Tree

Tree Cycles

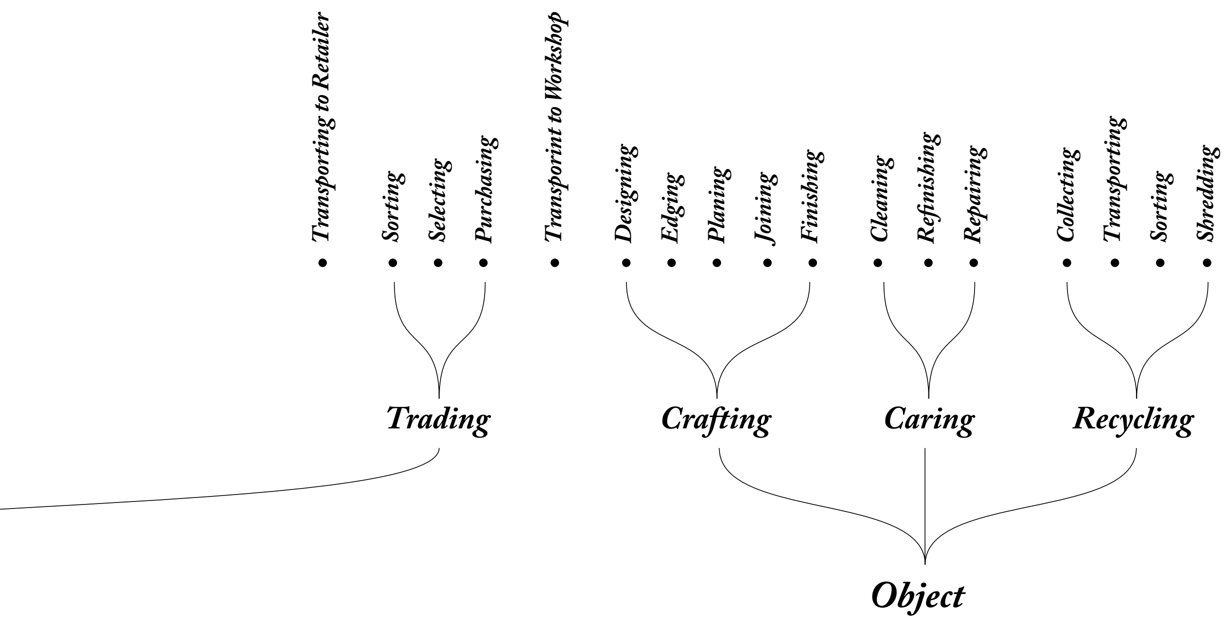
4.1 Maple tree canopies in Dumfries Conservation Area.

Learning to recognize and name trees might be the first step in gaining a deeper understanding of trees and forest systems, but only if it helps us to understand the impact that our actions have on these natural systems. Like us, trees go through the cycles of life. They are brought into the world through sexual reproduction, grow, reach their maturity, develop their own sexual organs, propagate their species, and decline until their deaths returning to the ecosystems as raw material. The tree's life begins with its growth in the forest, either naturally or planted by humans. As it matures it encounters the forces which literally shape it. It lives amongst and competes with other trees and flora for light, nutrients and water. It is damaged or overcome by insects, or helped by them. Birds, mammals take refuge on it, in it, or under it. Ice and wind storms tear apart its limbs. Humans tend to it, using it for food and sap, or cut it at will using it for shelter, fire and food. We affect tree life directly, through cultivation and harvesting, or indirectly by impacting global weather or introducing invasive insects. Our need for wood materials fuels an industry which directly shapes and reshapes forest ecosystems on a massive scale.

The process by which trees become usable wood usually takes place hidden from view in forests and sawmills. Is it possible to draw a line from the source of the material, through the various steps of its transformation, and finally to the ways it is crafted into buildings and objects for our lives? What role do architects have in this transformation and how might they influence it for the better? Again, with Cambridge as a base for learning and exploration, I began to trace the transformation of trees and forests into the wood products that we are more familiar with. This progess took me from the forest where the wood was harvested, to the sawmill where it was milled down, the retailers where its was sold, and the workshops where it was crafted and used. At each step, the wood became increasingly removed from its origin both geographically and in shape and form.



4.2 Steps in a timber cycle.


Transporting to Retailer
Sorting
Selecting
Purchasing
Transporint to Workshop
Designing
Edging
Planing
Joining
Finishing
Cleaning
Refinishing
Repairing
Collecting
Transporting
Sorting
Shredding
Trading
Crafting
Caring
Recycling
Object

Growing

Where Galt now stands was then a forest solitude. Huge pines, cedars, and elms, intermingled freely with oaks, and occasionally with beeches and maples, studded the valley and surrounding hills. Close to the river's banks, cedar predominated.

– James Young, Reminiscences of Galt

5.1 Mature and young trees growing together in FWR Dickson Wilderness Area. The newer thin trees rise upwards to reach sunlight near the forest canopy, before beginning to grow outwards in diameter.

Trees grow where they can, in places and situations that were they might land as seeds and where the light, nutrients, climate might be suitable for their survival. As such there is strong relationship between a tree and the place where it grows. Many species have evolved over millenia within particular geographical areas spreading where they can or retreating based on the conditions. Having a better understanding of trees might help us grasp the particular qualities of the places where we live and build.

Cambridge is located in Southern Ontario, in the St. Lawrence Lowlands regions, west of Lake Ontario, and north of Lake Erie. Until 15,000 years ago this area was covered in glacial ice with no sign of tree or plant. The forests of the region reformed with the retreat of the glacial ice sheets between 15,000 and 11,000 years ago.[1] Like humans and other animals, trees also migrated or spread from small areas, finding homes in suitable environments. Many of Ontario's tree species migrated into the region from present day eastern United States as well as Manitoba, with many species coming from seed refuges located in small geographic areas. Pollen samples show the introduction to Ontario of a number of coniferous species beginning 13,000 years ago, first with spruces, then red and jack pine, followed by eastern white pine and hemlock some millenia later. Around 8,000 years ago, a number of deciduous trees began to arrive in the region, with poplars and birches arriving first, followed by ashes,

1 *Ken Drushka, Canada's Forests, 5.*

elms, maples, beeches, oaks, and many of the other hardwood species we find today. The introduction of these and the struggle for space meant a decline in the populations of coniferous species leading to the mix of species that we encounter in Southern Ontario.

Climate, soil, geography and sunlight have a large influence on the type of trees that grow in a place. Climate, which includes temperature and humidity levels, is in turn effected by prevailing winds, which are influenced by latitude, proximity to water, and terrain topography. Soil is the layers of earth above bedrock which is composed of organic material which has been deposited over centuries. This provided the nutrients and material upon which the trees grow and thrive and contribute to when they die and decompose. Sunlight changes in duration and intensity based on the latitude of a region. This in turn effects the growing patterns of flora including trees. Being 1600 kilometres in length from north to south and covering 14 degrees of latitude , Ontario has numerous climate regions, from the cold tundra of the far north, to the humid continental climate of the southern regions.[2] Moving southwards through Ontario, the temperature and degree days increase, and so the forest composition also changes. Southern Ontario is considered to be part of the humid continental climate area according to the Köppen climate system, with brisk and cold winters and hot humid summers. Towards Lake Erie, the moderating effects of the water average summer temperatures increase, allowing for longer summer growing periods. Changing levels in C02, and other greenhouse gases mean that temperatures are and will increase over the years. A sustained warming trend could mean the migration of tree species northwards.[3]

Before human intervention, the geographic range of tree species would have been limited by the above conditions, but today, humans put limits on where

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2 K.A Armson, Ontario's Forests, 12.

3 Distrubution of Tree Species: < https://www.nrcan.gc.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/forest-change-indicators/distribution-tree-species/17778, accessed April, 2018.

5.2 A mature black cherry tree split near its base. The tree rests precariously on another trunk waiting for wind or foresters to bring it down.

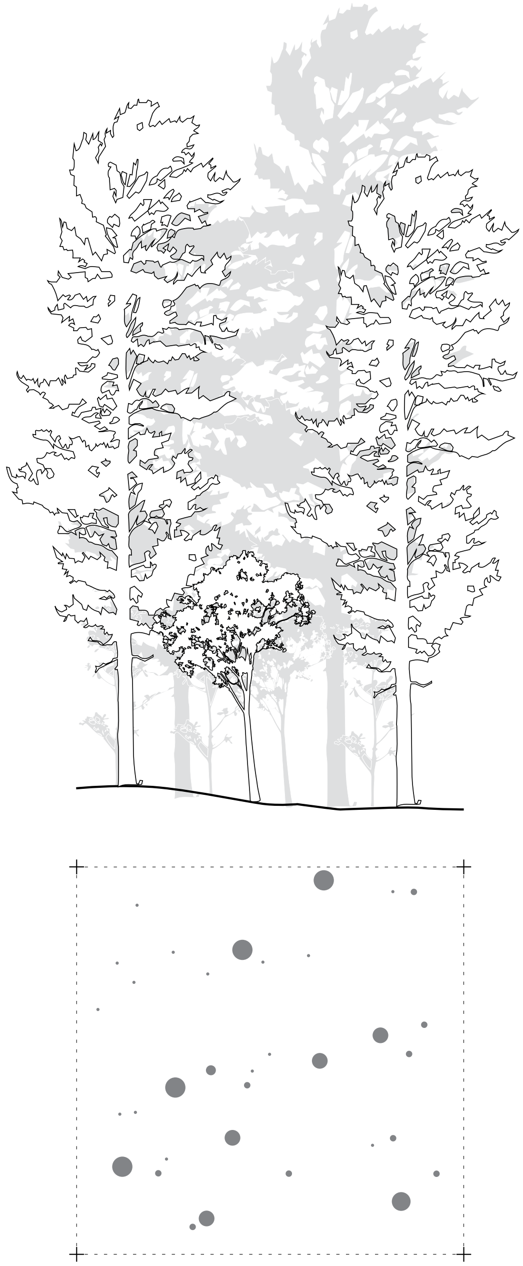
trees can grow, especially in densely populated areas like Southern Ontario. Today, the woodlands that remain in Cambridge are either in private properties, farm woodlots, or public lands held by various levels of government.

Revisiting these sites with some knowledge of tree identification, can start to give us some clues as to the composition of species which grow in the region. Visiting a sample of forested sites in Cambridge, a 10m x 10m square is marked out with sticks. The trees inside of this area are mapped and identified using tree guidebooks. This simple exercise show us a sampling of the trees in the region and starts to tell a story of the unique geography and ecosystems of the region, as well as the potential human influence. The first sample, at Sudden Tract, was dominated by nine mature eastern white pines with an under-story of black cherry, maple, and dogwood trees. These white pines may have been part of a reforestation program in the first half of the 19th century. The recent harvesting of these mature trees is now leaving space for the growth of native hardwood species which once grew here. The second square, at Dumfries Conservation area, reveals a very different mix, with 13 trees of the same species, white spruce. These trees were also part of a reforestation program, but have not led to a regeneration of hardwood species, instead remaining as a monoculture plantation. The third square at Victoria Park near the School of Architecture, held three mature red oak and one white oak which may be more than 100 years old. These reach over 50 feet in the air, towering over the understory of sugar maples and dogwoods which may one day dominate the forest as the oaks continue to die and fall. The last square, at RARE Charitable Reserve, holds a huge group of densely packed eastern white cedars which thrive in place where other trees might not grow, such as marshy lands, acidic soils, and rock faces.

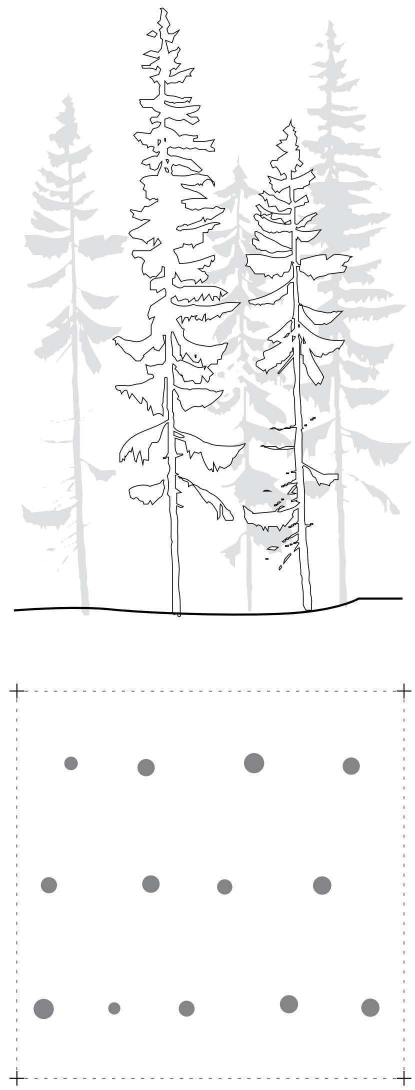
5.3 Plantation of non-native Norway spruces in Dumfries Conservation area, Cambridge.

5.4 Following pages: 10m x 10m samplings of Cambridge forests.

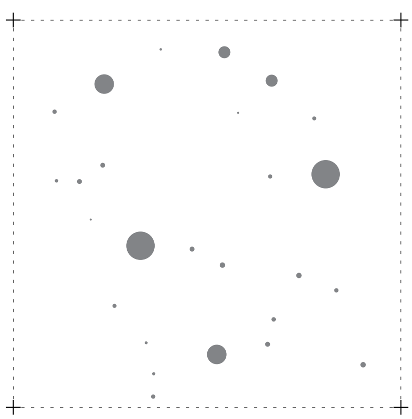
This exercise starts to bring into focus some of the key species which grow in the region and points towards the various forest regions we find in Cambridge. The Grand River travelling from its source near Dundalk, Ontario and southwards through Cambridge, and further to the mouth of the river near



Sudden Tract
9 Eastern white pines
5 Dogwood
3 Maple

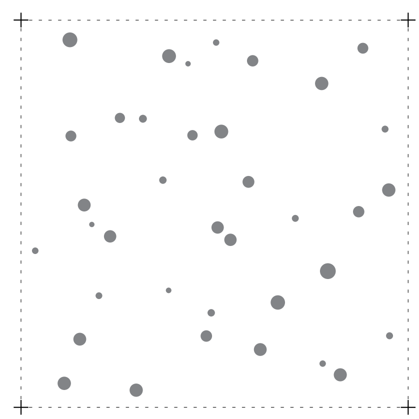


Dumfries Conservation Area
13 White Spruce



Victoria Park

2 Red Oaks
1 White Oak
4 Sugar Maples
5 Dogwoods



RARE Charitable Reserve

38 Eastern white Cedars


Picea glauca
White Spruce


Picea mariana
Black Spruce


Pinus rubra
Red Pine


Pinus strobus
White Pine


Pinus banksiana
Jack Pine


Larix laricina
Tamarack


Thuja occidentalis
White Cedar


Juniperus virginiana
Eastern Redcedar


Tsuga canadensis
Eastern Hemlock


Abies balsamea
Balsam Fir


Juglans nigra
Black Walnut


Juglans cinerea
Butternut


Gleditsia triacanthos
Honey Locust


Fraxinus nigra
Black Ash


Fraxinus americana
White Ash


Salix nigra
Black Willow


Tilia americana
Basswood


Betula papyrifera
White Birch


Betula alleghaniensis
Yellow Birch


Liriodendron Tulipifera
Tulip Poplar

Platanus occidentalis
American Sycamore

Sassafras albidum
Sassafras

Carya ovata
Shagbark Hickory

Carya ovata
Bitternut Hickory

Populus tremuloides
Trembling Aspen

Populus balsamifera
Balsam Poplar

Populus grandidentata
Bigtooth Aspen

Populus deltoides
Eastern Cottonwood

Acer saccharinum
Silver Maple

Acer saccharum
Sugar Maple

Acer negundo
Manitoba maple

Acer rubra
Red maple

Quercus macrocarpa
Bur Oak

Quercus velutina
Black Oak

Quercus rubra
Red Oak

Quercus alba
White Oak

Castanea dentata
American Chestnut

Fagus grandifolia
American Beech

Ulmus americana
American Elm

Prunus serotina
Black Cherry

Port Maitland on Lake Erie, passes through two of Ontario's four forest regions, the first being the Great Lakes-St. Lawrence forest, also known as the Alleghanian forest, and the Carolinian forest further south. Each of these contain distinct mixes of species and ecosystems within there bounds. Cambridge has the special benefit of being situated on the transitional area between the Alleghanian and Carolinian forests, making it possible to find species from both regions.

5.5 Previous pages: Distribution ranges of tree species native to Ontario.

5.6 Tree ranges overlaid. This map shows the unique geographical position of Southern Ontario, sitting in the transition zone between the deciduous forests to the south, and the mixed and coniferous boreal forests to the north.

North of Cambridge, the Alleghanian forest is home to many common deciduous species such as sugar maple, beech and oak, alongside coniferous species such as eastern hemlock, white pine and eastern white cedar. The regions extends northwards past Sudbury where it transitions into the vast boreal forest which covers much of northern Ontario and much of Canada. The boreal forest is composed mostly of coniferous species such as spruce, pine, fir, and tamarack and some deciduous trees such as birch and aspen.[4] These trees have evolved to grow in harsh climates with cold and long winters and short summers. Although the land is vast, it is sparsely inhabited, with a number of towns, settlements, and reserves many of which contribute to the logging industries of the north.

Moving south of Cambridge, we enter the Carolinian Region with its mix of hardwood species such as sugar maple, oak, basswood and beech trees and unique species such as black walnut, sassafras, tulip tree, hickory, sycamore, cottonwood, and chinquapin oak, not found anywhere else within Canada.[5] This region, although heavily deforested and populated, is known for its rich biodiversity owing largely to these unique forest ecosystems. This diversity and species mix is a result of warmer temperatures and hot humid summers, which it shares in common with much of the eastern United States. The Carolinian Forest is in fact at the northern end of the Eastern Deciduous Forest which runs through twenty-six of the eastern most states.

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4 Drushka, 10.

5 Gerald Waldron, Trees of the Carolinian Forest, 25.


Boreal Forest
Great Lakes-St.Lawrence Forest
Cambridge, Ontario
Deciduous Forest

5.7 A fallen red oak in Victoria Park and a maple growing. A hole is left in the forest canopy where the tree stood. Red oaks need periodic fires to clear out competing species and undergrowth. Without this, the trees continue to fall. The silhouette of the ascending maple trees are seen in the foreground. These will dominate the forest.

The Human Impact

Some of the earliest physical evidence of inhabitation in the forests of the Cambridge region come from the discovery of Neutral indigenous peoples settlements close to the banks of the Grand River in Kitchener dating to approximately 1500 AD, but containing artifacts dated to 11,000 years ago.[6] The remnants and post-holes of long house structures were found here, pointing to an early use of the trees in the region for shelter. Excavations of long house building show that these structures were often constructed of locally sourced wood poles, bent to form curved members which form the structure of the long house. Often the structures were clad in tree bark and joints wrapped in twine from the tree roots. The people who inhabited this site would have lived and evolved for thousands of years alongside the forests of the region, and developed the knowledge and skills to make use of the trees and its materials for every need, including buildings, clothes, food, transportation, art and weapons.

The forests in Cambridge, and much of Southern Ontario, have changed dramatically changed over the last 300 years. One of the first earliest written accounts of the region, by Samuel de Champlain in his book *Les Voyages de la Nouvelle France*, gives a description of the landscape near Lake Simcoe as lush with oak trees, elms, beeches and other species similar to those of his native France. He recounts the shape and size of the long houses of the indigenous peoples made using local trees and plant materials.[7] These indigenous groups evolved over thousands of years within the forests but did not harvest or cut enough to drastically alter the landscape. These forests would have dominated the region until the arrival or large numbers of European settlers in the early 1800's. The town of Galt was settled in the early 1800's on land that was part of the Haldimand Proclamation of 1784, which granted a tract of land to

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6 CTV News [Major archaeological find unearthed in Kitchener], <https://kitchener.ctvnews.ca/major-archaeological-find-unearthed-in-kitchener-1.566066>, accessed March 2018.

7 Samuel de Champlain, Travels in New France, 313.

the Haudenosaunee led by Thayendanegea, also known as Joseph Brant.[8] The tract included land 10km to either side of the Grand River from its source to its mouth. However this land quickly found its way into the hands of series of white owners including Block 1, The Township of North Dumfries, which eventually was sold to William Dickson of Scotland.[9]

In his description of the founding of Galt in *Reminiscences of the Early History of Galt and the Settlement of Dumfries*, James M. Young describes the travels of William Dickson and Absalom Shade in 1816, through the recently purchased Township of Dumfries. Young's description of the area paints a picture of a vast mixed forest with little human settlement, dominated by large pines, cedars and hardwood species like oak, beech, maple and elm.[10]

As one of the first European settlers of the region, Dickson went on to develop his lands along the Grand River, with a sawmill being one of his first investments, to take advantage of the huge quantities of timber. As the town developed and more settlers arrived, other important buildings were added, including the grist mill, post office, and public hall. With the hard work of felling trees and removing stumps, the surrounding land was painstakingly turned to agricultural uses and the forests depleted. Settlers would make use of the wood on their land to build the necessary homes and barns, and for firewood for cooking and heat. Slash-and-burn was a method of clearing the land using fire to destroy the existing plant and tree life on a site to make way for other crops. This pattern of settlement continued for much of the 19th and 20th centuries throughout much of Southern Ontario, with the forests providing raw material for expansion and development. The fledgling railway networks made extensive use of the forest timbers for ties and fuel, and contributed to the movement of people, goods, and ideas across Canada. Even before this time, large amounts of timber, especially eastern white pine, were harvested and shipped to England for ship building for the Royal Navy.[11]

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8 Theresa McCarthy, In Divided Unity, 84.

9 Young, James M. Reminiscences of the Early History of Galt, 34.

10 ibid, 36.

11 Drushka, 23.

5.8 A grey tree frog sunbathing on a horizontal tree trunk in Sudden Regional Forest. Its Latin name, Hyla versicolor, points to its ability to change colour, camouflaging itself to avoid predators.

Today, if we travel into the countryside north of Waterloo and Kitchener, we find signs of the Old Order Mennonite and Amish populations which have made this there home since the early 1800's. These Anabaptist settlers brought with them the woodworking traditions of their German and Dutch ancestors and settled into the wooded landscape of their new home. Many first immigrated to northern United States including New York state and Pennsylvania. As they sought new homes or escaped persecution, they moved northwards into Ontario, and were some of the earliest settlers to the region. Their expertise in carpentry and woodworking grew in reputation, as they shunned the trappings of modern life for traditional techniques and manual labour. Today, although modernized with CNC's and computers, there workshops and sawmills still dot the countryside centres in towns such as Elmira and Wallenstein.

The rapid growth and expansion of Southern Ontario throughout the 1800's and early 1900's led to the near extermination of the native forest of the region, with large tracts of land being overcome by sand and dust as they fell into disuse after being over farmed.[12] In the early 1900's, the harmful nature of this deforestation started to become apparent, and the conservation of forests and natural landscape started to enter into mainstream conversation and amongst politicians. This led to a general awareness of conservation policies and the need to protect land before it developed into farms or urban areas. This movement met with great opposition but every piece of forest or woodlot that remains today in the Cambridge region is the result of someone's desire to protect the natural systems.

These public lands make up a small percentage of today's remaining forest, with the majority remaining on private lands in the form of farm woodlots. Woodlots provided timber for fuel and building to farmers and were essential to the lives of the farmers. Today, these woodlots have become less crucial to the farmers, and are under threat as they seek to maximize farming areas

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12 Drushka, 39.

5.9 *Aerial views of Victoria Park from 1945, 1955, 1966, and 2018. The urban development of Galt gradually encroaches on the bounds of the forest. University of Waterloo Map Library. 2008.*

1945

1955

1966

2018

and profits. To counter this, counties around Ontario have varying degrees of legislation that require certain percentages of the land to remain as woodlots. The shapes of the woodlots are not ideal, as they are often discontinuous and unconnected, separated by large fields, roads, and ditches, making difficult or impossible for wildlife to move between them. These are harvested from time to time, with mature valuable lumber felled and sold for profit. Sugar maple bushes also provided a secondary income to these farmers, and the tubes and lines of these operations can still be seen today zig-zagging through woodlots.

Fires, Insects, and Disease

The alteration of forests by fire, disease, and invasive species are directly related to human actions both locally and globally. As a combustible material, trees and wood are subject to burning in various forms. Forest fires, caused by lightning during dry moments, are a natural part of many forest ecologies. By burning through old or damaged undergrowth, they open up space for new shoots to arise. Many tree species within Canada's boreal forests have evolved along side forest fires and require their heat to break open new seeds. More locally, forest fires were an essential part of the native oak savannahs, removing competing trees and allowing the oaks, which need full sunlight, to grow through.[13] The conflict between forest fires and human occupation is constantly in play, as witnessed in the Fort McMurray fires of 2016. Human occupation of forest regions means that we are susceptible to fires. We effect these regions most greatly through fire suppression, the putting out of fires deemed dangerous. In the case of Fort McMurray, years of fire suppression left a large stock of standing dead trees and combustible material which normally would have been moderated by periodic burns. This opened up the possibility for a catastrophic event such as occurred.

13 Red Oak. < https://www.ontario.ca/page/red-oak>, accessed June 2018.

In Southern Ontario fire suppression is also practiced to prevent any destruction to homes and structures in the heavily populated area. This suppression causes a shift in the types of forests that exist, as undergrowth which is not naturally cleared out can take root and supplant existing tree canopy types. An example of this can be seen in Victoria Park in Cambridge. Here, the mature red oaks which dominate the canopy and evolved to withstand forest fires, are being succeeded by a maple trees which would not normally survive a forest fire.

We also use fire in a controlled manner to affect the growth of forests or to clear dead and decaying material. These prescribed burns are carefully controlled and are a method of forest management. However they rarely can take place in heavily populated areas due to the risk of the fire spreading.

Our actions effect trees and forests in unexpected and unintended ways. The global trade of timber and wood packaging has caused a number of catastrophes for local tree species over the years. These generally take the form of introduced pests and diseases from foreign places, which then attack local trees which have not evolved any form of resistance. In 1904, a fungus (Cryphonectria parasitica) was found to have infected chestnut trees in the Bronx Zoo. It was introduced from Japan in nursery stock and was fatal to the trees. By 1920 the blight had reached Southern Ontario's Carolinian zone and by the 1930's had infected or killed most chestnut trees, one of the most prolific species in eastern North America. The trees were the primary wood species for construction in the Appalachian Mountains and also provided a rich source of food. Both of the industries were destroyed and today only reclaimed chestnut wood is available.[14]

Dutch Elm Disease was introduced again to New York in a shipment of veneer logs for the Ohio furniture market in 1928.[15] Also a fungus spread by elm bark beetles, the disease spread across much of North America, destroying

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14 Olaf Schmidt, Wood and Tree Fungi, 165.
15 ibid, 168.

58 million trees, reaching Ontario in 1967 and affecting 80% of Toronto's elm trees by the 1980's. In a second wave of migration, a more virulent strain of the fungus was reintroduced to Europe from Canada in a shipment of Rock Elms. This strain killed most of the elms in England and France by the 1990's.

5.10 A tree devoured. The radiating galleries of a bark beetle larvae seen on a fallen log in Sudden Tract. The bark beetles carry fungus such as Ascomycota sac fungi in the case of Dutch Elm Disease, which feeds on the tree tissue, causing first leaf wilt and the eventual death of the tree.

In 1996, the first case of the Asian Long Horned Beetle was found in Brooklyn, New York and most likely was introduced in solid wood packaging from Asia. It soon made its way to Ontario affecting maple, birch, poplar, elm and willow. The disease has been controlled in Ontario for some time but was again detected in 2013 in Toronto.[16]

The most recent epidemic, the Emerald Ash Borer, continues to works its way through North America. It was also introduced from Asia in wood pallets or packaging material and was first detected in Michigan. Millions of ash trees have been affected are rapidly being felled throughout Ontario. This has created a surplus of ash wood which is ironically in high demand in parts of Asia such as China for use in furniture. Ash was a favoured species for planting in the suburbs of Toronto because of its hardiness and resistance to pollution. Entire streets which were planted with ash were left bare after the ash borer and subsequent culling of trees.

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16 Asian Long-Horned Beetle. <https://www.ontario.ca/page/asian-long-horned-beetle>, accessed July 2018.

10 square meters of Sudden Tract

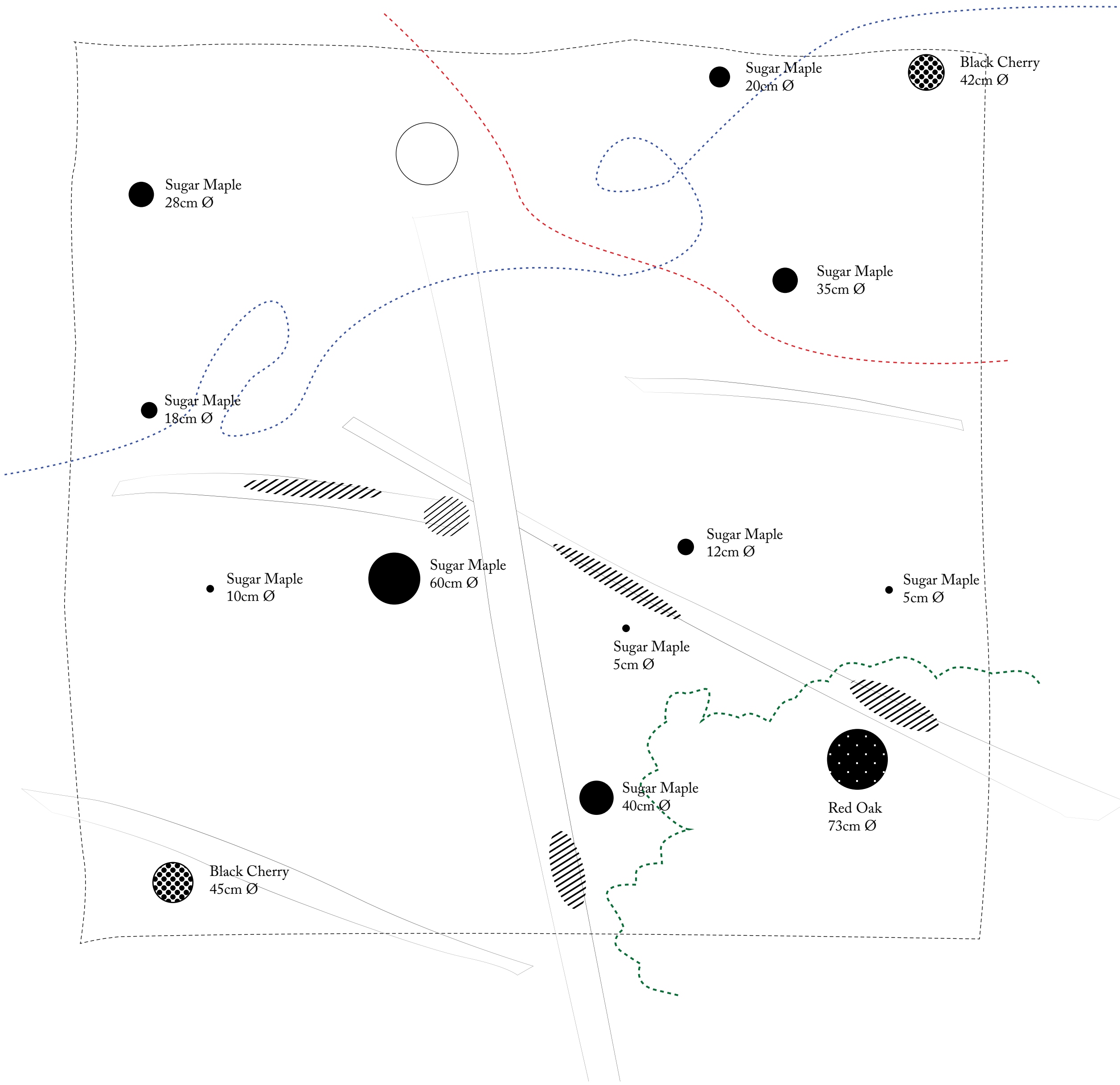
5.11 Oak tree towers over the 10 square meter plot in Sudden Tract

The trees which we use for our wood products do not grow in isolation, but are part of larger ecosystems of other plant life, animals, insects, funghi, microbes, and other living organisms. These ecosystems use available energy sources, most notably the sun, along with water and nutrients to grow and prosper. Forest trees are responsible for the large majority of photosynthesis in the forest system and are therefore crucial components in the health of all forest life. In turn they rely on other organisms for their own survival.

Sudden Tract is one of a handful of regional forests in the Cambridge area, sitting just over seven kilometres southwest of the school on Spragues Road, surrounded by farmland in the hills of North Dumfries. At 219 acres, it is one of the larger forested lands in the region, well used with a network of maintained trails and small boardwalks.[17] I first came here in second year of architecture school, and returned many times since, drawn to the sound of birds, the large trees, and the variety of plants and small creatures. There are plantation forests here of red and white pine, planted in the 1940's and maintained to this day, alongside more natural forest mixed forest types with large hardwood trees. What could I learn about the ecosystem here? It would be difficult to survey the entire forest, but easier to observe and map a smaller piece of land. The purpose of this exercise was to understand the ecosystem and physical features that surround the trees that we might use for wood products.

With a thin rope and some twigs, I marked out a 10 square metre plot of land, about 20 metres off of a trail at the north end of the forest. I wanted to see what trees grew here, and what other types of plants, animal, insects, fungi, and anything else that were part of this ecosystem. The forest appeared fairly uniform in the area, with tall hardwoods, short undergrowth, and leaf

17 Sudden Regional Forest, <https://www.regionofwaterloo.ca/en/exploring-the-region/resources/Documents/Sudden-Regional-Forest-access.pdf>, accessed on September, 2018.



5.12 Diagrammatic plan of ten square metre plot of Sudden Tract litter, and so I chose a spot with a mix of larger and some less mature trees. After marking the spot, I drew a quick plan, using a measure tape to gauge the distance between the trees and their diameter. Two large trees dominated the square, with radius' over 60cm, six trees over 20cm in diameter, and 5 trees under 20cm. Observing the leaves in the tree canopies, I noticed the largest tree was a northern red oak, which was towering well above the canopy of the other trees. The others were a mix of sugar maple and black cherry, with the narrowest trees all sugar maple. All of the trees grew straight upwards, without any branches for the five or six metres of their height. Even the narrowest trees at five to ten centimetres in diameter grew upwards almost reaching the height of the most mature trees, clearly trying to compete for the same finite amount of solar power. Later I learned that many forest trees will tend to grow upwards relatively quickly towards the sunlight, before this vertical height lessens and their trunks grow horizontally. This vertical growth creates a feeling of openness and height within the forest, with columnar trunks instead of branches dominating the visual field. The canopy on the other hand creates a lacy atmosphere, filtering the sun through the millions of leaves that form the depth of the forest canopy. The filtered sunlight means it is less intensely hot than outside of the forest, and yet it feels more humid here, with less breeze flowing through than the open air.

The ground is fairly dry without rain for the last few days, and everywhere covered by oak and beech tree leaves from the previous autumn, which seem to be more resilient than maple leaves. The ground here slopes almost 2m within the space of 10m, which seems typical of this hilly part of the forest, which contrasts to the low swampy parts of the forests which seem to be perpetually wet and muddy. Here the ground is firm and dry and must drain

5.13 Photographs of flora and fauna found in the 10 square metre patch of Sudden Tract.

well. There are a number of rotting logs within the 10 square metres, ranging from 15 to 50cm in diameter. The largest was once growing within the square, and now its stump is barely visible, decomposing amongst the other leaves and branches. The logs, which may have been laying here for years, are now covered in different types of growth. A strange miniature forest of thin fungi grows out of the end of one log, and on another a cluster of horizontal shelf like mushrooms grow off of the side. This same log has a large patch of moss on its top surface, with thin red sporophyte stalks with tiny capsules which seem opened, having released their spores some time before.

A number of plants and ferns grow here, including the red and white baneberrys with their vibrant shiny spheres. There are also many small creatures here, some that seem to make this small plot of land their home, and some that seem to just pass through. A black and violet butterfly flutters through, stopping briefly at a small purple flower and then moving off again. Many tiny harvestman stalk through the forest floor, their tiny red bodies and slender legs barely noticeable. A small frog, the size of a golf ball, hides under a leaf with its slimy skin and dark stripes. He takes a small hop as I approach and then site quietly in a corner of the site until I leave. The mosquitoes and small flies whir everywhere, many coming straight for my eyes and ears. Within half and hour many dragonflies buzz past, some circling but never staying. A number of birds fly above or can be heard chirping near by.

Harvesting

6.1 A typical woodlot in Southern Ontario. The woodlot sits at the back of farm property, visible from the road but inaccessible.

It's a clear and sunny day in Perth County, Ontario. I'm visiting a logging team working in a farmer's woodlot near Lucknow and supplying logs to a sawmill near Cambridge. There's no address given, put they provide a 'pin' on Google maps. I find the muddy road and drive a few hundred metres into the corn crop, stopping at a clearing where a pile of cut logs, a tractor, a pickup truck, and a couple of dogs wait. I'm greeted by a man in a tractor pulling fifty foot logs into neat piles. I hear saws in the distance, a creeping crack from far off, and the thud of a tree falling. The sound comes from the woodlot next to the corn field, where another two loggers are busy working out of sight.

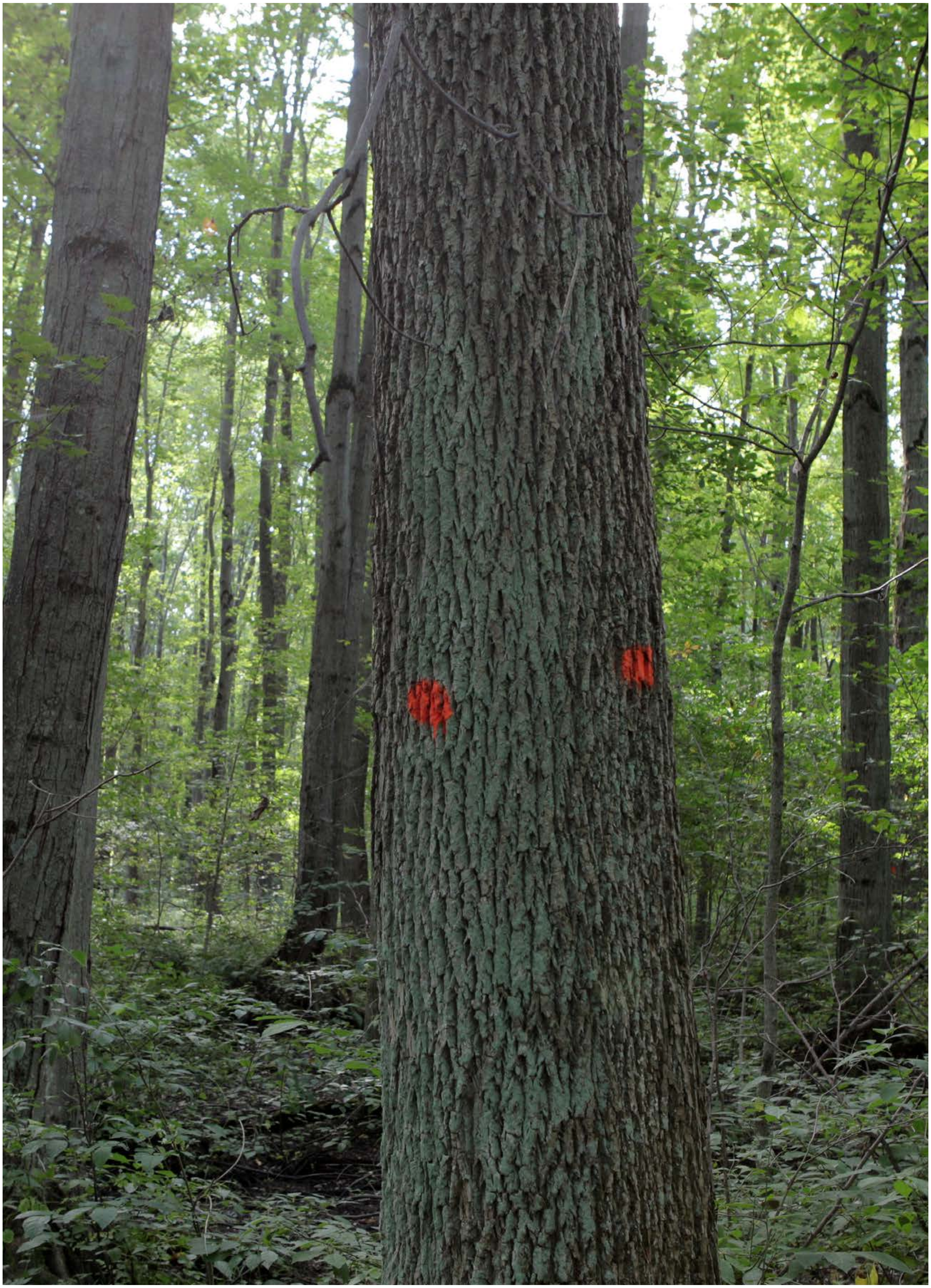
The two other loggers come out of the forest on a skidder some time later to greet me. After a short water break we head back into the forest together. It's a walkable distance but we take their pickup truck instead, the puppy chasing behind. The mud road was created for this logging job and hugs the boundary of the woodlot. The corn here had to be cut. Not ideal for the farmer, but necessary for the loggers. They tell me that much of this corn had already been damaged by animals venturing out from the woodlot, seeking an easy supply of food. Later I see corn husks and kernels strewn deep in the woods, no doubt remainders of these meals. This access road will be planted on again next year until the next tree harvest, in 15 to 20 years.

Along the road, there are number of openings into the forest where the loggers have previously worked. Tire tracks and broken branches can be seen emerging from these openings. We enter one of the access points and enter the woods. It's calm and still, and dense with undergrowth and trees of varying sizes. The bright sun enters sparsely through the dense canopy. A few birds call here and there but no animals to be seen, although raccoons, squirrels and white-tailed deer make this there home. This woodlot is fairly swampy, the ground being damp. Mosquitoes whir around and spider webs hang between trees at all heights. Poison ivy creeps on the ground and up the trees. The logger tells me that even the dust is enough to cause a reaction, and shows me a deep red rashes on his forearms.

6.2 A tree marked for felling. The spray-painted dots can be seen from far way in the green and brown forest.

The trees are around fifty feet tall and are mostly silver maple and white ash. Many of the ash are dead owing to the emerald ash borer infestation. I counted the rings and many of the felled trees were around 60 years old. I spot a few black cherry trees. The logger mentions that a part of the forest is a sugar maple stand which is tapped for syrup. They won't be cutting these down. Before the logging crew sets foot in the lot, the forest is surveyed by a registered professional forester, who then creates a plan for the harvest including the number of trees to be felled, and any environmentally sensitive conditions or areas to be protected. Part of the process is the timber cruise, where the trees to be felled are marked, often with spraypaint. This harvest, like many that take place in smaller lots in Southern Ontario, is a selective logging process, where the forest ecosystem is largely maintained and only select trees at the prime of their potential timber value are harvested periodically. This is in contrast to the clearcutting method used in many plantation forests in the boreal regions of Canada, where a large area of forest is clearcut, then scarified or burned, and a new generation of trees planted for future harvest.

One logger has the task of felling the tree. His primary tool is the Husqvarna chainsaw with which he makes the cuts into the tree. He also wears a belt to carry an axe, two wedges, a scrench for maintaining the chainsaw, a chainsaw file, and a walkie-talkie for communicating to the team. I'm surprised by how quickly the loggers work, within a few minutes observing the tree, choosing a direction for the fall, and making the cuts to bring it crashing down. The direction of the fall is important, as the tree should fall directly to the ground. If it were to get caught in other trees, bringing it down would become even more unpredictable and dangerous. Each tree typically leans in a certain direction, and this lean sets the general direction for the logger to work with as felling a tree against the lean might have unpredictable results. He must also observe



the tree for any imperfections that might cause it to split or kick back towards the logger when it is falling, potentially causing serious harm. These 'widow-maker' trees must also be watched while falling and if they split, the feller has no choice but to run quickly away to avoid an errant and dangerous fall.

6.3 A logger makes the first wedge cuts with a chainsaw.

6.4 Tree with the wedge cut removed.

After choosing the direction and finding a gap in the trees ahead, the logger then makes the first cuts on the side of the tree facing the fall. He makes a horizontal cut with the chainsaw a few inches above the base of the tree and about a third of the way into the tree, followed by a diagonal cut from above. This removes a wedge shaped block and creates a hinge which helps to direct the fall. He then creates a horizontal cut, called the 'back-cut' from behind to topple the tree. A few times the tree started its fall without any extra work. Most of the time he would hammer wedges into the back-cut to initiate the fall. One one occasion the skidder was used to push the tree in the right direction. The trees fell slowly at first, but then quickly picked up speed. The logger stepped out of the way with eyes turned upward to the falling tree. The canopy branches collided and whirred through the standing trees. Leaves and branches crackled and snapped as they fell and finally the 50' trunk landed with a deep thud against the earth. The sound was quieter than expected but the power could be felt in the shaking ground. Even after the tree had fallen dislodged leaves floated to the ground like confetti.

The tree was then 'limbed', with all of the extraneous branches, leaves, and canopy being removed by chainsaw, leaving only the high-value cylindrical log remaining. The logger explained to me that these discarded parts of the tree were left on the site to decompose over time, providing beneficial nutrients and material to the forest soil. After two or three of the trees had been felled, the skidder is driven in to collect the logs and transport them to a central landing area. Another logger drives the skidder, a four-wheeled tractor used to pull fallen logs out of the forest, and to push stubborn trees during felling. The skidder turns around an articulated joint in the centre of the machine between the two sets of wheels, instead of turning using the front wheels. This makes it

6.5 Time lapse of a skidder pushing a cut tree in the desired direction

highly maneuverable and the driver zigzags at a good speed, dancing between trees of all sizes while trying to damage as little as possible. Even young trees a few inches in diameter are maneuvered around by this multi-tonne truck and its driver. The logs are secured to the skidder using a steel choker cable, which tightens when the cable is in tension as the skidder drives forward. It leaves the logs just outside of the forest edge from which they are pulled by the third logger on a smaller tractor and taken to the landing. He lines them up and begins bucking the logs. This is the process of cutting down the full tree lengths to smaller more manageable lengths optimized for the desired end product dimensions. Using a 4' steel measuring frame, he quickly scans the logs for uniformity and straightness and marks out the cuts, leaving a few inches extra on each end of the board length. After cutting the smaller logs with the chainsaw, he stacks them into neat piles using a jawed arm on the tractor. The cycle of felling, skidding, bucking, and stacking continues until all of the marked trees have been felled in the woodlot. This process can take days or weeks depending on the size of the property with this crew felling around fifty mature trees per day.

6.6 Logger watching the falling tree, making sure his aim is accurate.

6.7 Tree canopy left on the forest floor.

The way that these trees were harvested is by no means the way most trees are harvested, but it is the most common method in Southern Ontario and the Cambridge region, with its small woodlots and forests. The different methods of forestry each have associated impacts on the ecologies in which they occur, ranging in scale from plantation forests, which are created with the goal of mass logging, to small-scale operations in private woodlots. Clear-cutting is common practice in the softwood lumber, paper and pulp industries, which require large volumes of timber product produced at the cheapest possible cost. Often large machinery is used, including robotic logging to clear the largest number of trees in the shortest amount of time. These methods also come with the creation of large resource road networks which are often abandoned after one use and which take years to grow over. Monoculture, or the lack of diversity in these plantations forests, can lead to ecosystems which are far less complex and resilient than natural forests, containing fewer animal, insect or plant life. This means that the forests may be more susceptible to disease or

other adverse conditions. They are also far less attractive as recreational areas because of the monotony.

6.8 Butt end of a tree trunk being attached to the skidder with a choker cable.

6.9 Skidder pulling out the felled trunk.

In the Cambridge region, selective logging is the most common way of harvesting timber, with small groups of loggers entering forests and often cutting the trees by hand. Prior to the cut, a registered forest professional will mark which trees are to be cut, in accordance with a government quota, and submit a plan to the local municipality to obtain a logging approval for the work. The small scale of the works is less impactful than clear cutting, but still affects the forest in many ways. The skidders and machinery used can create heavy ruts in the forest floor, disturbing all types of organisms in the process. The canopies and stumps of the trees are also left to decompose on site. They say that this is similar to a tree naturally falling and so has less impact on the site then completely removing tree, with the leaves and branches provided raw material and nutrients for the next generation of trees. Selectively removing trees is also thought to provide saplings a chance to grow as light and space becomes available with the felling of the mature tree.

The traditional use of horses to remove and transport logs was used for centuries before tractors, and would cause even less disturbance to the forest depending on the frequency and scale of the operations. Even today there are a few logging companies who specialize in using horses. At these least invasive end of the spectrum might be the cutting of single trees or the use of trees which have fallen from natural causes.

6.10 Bucking the log. The logs are marked and measure before being cut it into smaller more manageable lengths.

6.11 Log pile.

6.12 Opposite Page: Wormy maple log, with staining from the fungus spread by the ambrosia beetle.

Milling

7.1 A sawmill near Lucknow, Ontario. The sawmill debarks red pine trees for use as hydro poles.

The Grand River was once home to many sawmills making use of its tremendous power. Few of these traditional mills remain but the local wood industry thrives in pockets not far from the original sawmills. If you drive forty-five minutes from Cambridge in a northwest direction, you'll find yourself in a countryside of rolling hills, farmland as far as the eye can see, cows, sheep, horses grazing in the grass. The Conestogo river winds through the farmlands, on its southerly course, eventually joining the Grand River and its course towards Lake Erie. The land here is fertile and has been inhabited since prehistoric times. Everywhere there are signs of the Old Order Mennonites that make this area their home and have cultivated and prospered here for two centuries. In the midst of this agricultural land are a number of timber mills, the largest of which I was able to tour and better understand how the local hardwoods are transformed into usable timber.

The site was a few soccer fields in size, with the large warehouse and sawmill buildings at the centre. There were logs, timbers, wood stacked everywhere and conical piles of wood and bark chips dotting the site. The humming sound of the mill was ever present and yet the whole operation was calm and well rehearsed. From arrival to finish, the logs are taken through a number of steps over a period of weeks and months, that see them transformed into high-value timber products for use locally or regionally.

The logs first arrive on log truck from various logging sites within Ontario. The logs are then first arrayed on the ground, and graded according to their size, species and quality. A special wooden stick with a steel end, called a grading stick or lumber ruler, is used to calculate the board feet of the log. The logs are marked using spray paint, and then stacked into large piles by species and size, ready for sawing. The board foot volume measured here is used to calculate the pay that will go towards the loggers and in turn the property owner who the woodlot belongs to. As such this is an important step in the process for all parties.

The logs are loaded onto a platform and one-by-one rolled into the sawmill building. The sawmill is not as simple as it might seem. It's actually a large assembly of a number of different saws, metal framing, and conveyor belts arranged over two levels with four or five people operating at any given time. First the logs are debarked using a series of rotating wheels with teeth. The bark falls onto a conveyor assembly which disposes of it in a huge conical pile outside of the building. The round log is then headsawn into rough boards. An operator sits in a protected booth and controls the saw with a series of levers and buttons. The rough boards are then edge trimmed with a laser-guided double-bladed saw by another operator. Finally the ends of the board are cut on the lower level. Unlike dimensional lumber, the timbers here might be of vary different sizes in order to maximize the yield from each log.

Each milled board is then graded by an experienced grader who walks backwards on the conveyor as the pieces emerge. This was described as the single most important task in the sawmill operation as it determines the quality and therefore the price of each board. The grader flips the board using a lumber ruler, and then marks the piece with chalk to indicate its grade. If he under grades the boards, he devalues them and the sawmill will lose money. If he over grades then customers will become wary of the quality of the sawmill's boards and may take there business elsewhere. These boards are then stickered, meaning that they are stacked separated by a small wooden sticks, to allow for even air flow in the drying process. From here, the boards are either delivered green to the customers, or are taken to the next step of seasoning.

7.2 Cows grazing near Wallenstein, Ontario.

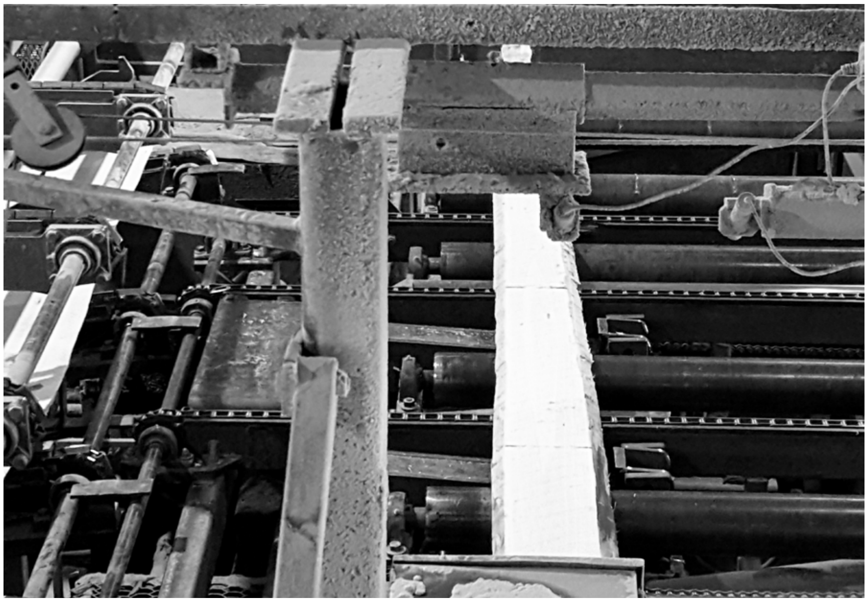
7.3 A horse-drawn buggy in front of a wood storage shed. The preferred transportation of the Amish and Old Order Mennonites.

7.4 Logging truck delivering recently cut logs.

7.5 A grading ruler lies on the new logs waiting to be measured and valued.

7.6 Logs lined up for measuring and sorting.

7.7 Logs being fed into the sawmill.



7.8 Board being fed into an edging saw.

7.9 Bark chips are conveyed away from the sawmill. The chips are used as animal bedding or mulch.

7.10 A sawmill worker grades sawn boards as they run down a conveyor. The grader is responsible for giving the board a grade and determining its value.

7.11 Piles of wood chips and square off-cuts.

Seasoning

8.1 An uncut log showing internal splitting of the wood caused by drying.

Almost all of the wood used for woodworking or architecture is seasoned before use. Seasoning is the process of removing moisture from the wood, and in doing so changing its physical properties. Like other living organisms, trees are composed of cells which work in harmony, each performing functions to maintain the survival of the tree. These cells rely on large volumes of water and other nutrients to work properly and trees use their roots to absorb this water from the surrounding ground. This absorption occurs through osmosis with the water travels upwards from the roots and through the xylem, or inner bark and upwards to the leaves.[1] This absorbed water can be found within the cells, often called 'bound' water, and also outside of the cells in tubular canals which transport water upwards through the tree. This is often called 'free' water. All of this internal moisture means that the wood of a freshly cut tree will actually feel wet when cut. Over time, the water evaporates, drying out the wood and changing the cellular structure of the wood. This drying process can have negative effects and cause the wood to deform in many ways such as by bowing, twisting, warping, splitting, and checking. If we were to build or craft with the wood before it is well seasoned, it would continue to dry and our work would be susceptible to these defects as time passes.

To make these defects more predictable and stable, wood is dried before it is used in craft or construction. This drying process, called seasoning, changes the internal structure and moisture content of the wood to bring it into equilibrium with the surrounding air. This mitigates future shrinkage, cracking or defects, creating a more stable and workable material. Seasoning takes patience, as the wood can take months to years to dry properly depending on the thickness and species.

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1 Hirons, 249.

8.2 *Ash wood being air-dried. The boards are stickered, stacked and left to sit until they reach the desired moisture levels.*

8.3 *Thicker boards and live edge pieces being kiln-dried.*

Air-drying

With air drying, the boards are simply left to dry in the open or in enclosed spaces. In the sawmill, these boards are stacked high in the yard, exposed to the elements year round. The boards are 'stickered', meaning they are separated by sticks which allow air to flow, drying the board evenly. The moisture content of the wood is checked from time to time until it reaches the desired level. As the wood dries its dimensions change, and if this happens unevenly it can result in cracking, warping and other defects which drastically reduced the value of the board. The amount of moisture will also dictate how much the board will expand and contract in different seasons and temperatures throughout its life.

Kiln-drying

Kiln-drying makes use of a large heated room to dry out wood in a controlled manner. Walking into the kiln is like walking into a sauna, with the smell of damp wood thick in the air. The boards are packed close and high but with enough space for air to flow. Kiln-drying drastically reduces the time needed to dry the wood and helps to achieve a lower moisture content than air-drying. Depending on the temperature it can also cause changes to cell structure, by driving out the moisture trapped within the cells and setting the lignin within the wood. This creates a stable and strong end product which will have less expansion and shrinkage than air-dried wood. The KD symbol found on most dimensional lumber shows that it has been kiln-dried to maximize stability and strength.

In some cases, neither of the methods are used, and the wood is used 'green' or without intentional drying. This can have its advantages. For example some types of furniture use the drying of the wood to create joints which become tighter and stronger as they dry.

Wood

Seasoning brings out many of the characteristics of the wood that we know and use, but not all wood is the same. Each species and each tree has its own characteristics, shaped by the forces that affected its growth and the ways it was felled, milled, and seasoned. Wood is an organic material, grown over the course of many years and subject to forces such as climate, geography, altitude, soil, wind, and sun, each of which impact the life of each species, each forest, and each individual tree. This in turn means each piece of harvested wood has a unique grain, colour, density, size, and smell.

9.1 A recently cut trunk of a tree with the chainsaw marks visible.

The Finnish architect Juhani Palasmaa, in *The Language of Wood*, argues that this richness of material qualities in wood, manifested in its tactile, acoustic, olfactory and visual characteristics, make it a welcome antidote to the increasingly synthetic and sterile nature of materials in contemporary architecture. He reiterates the importance of the sensory properties of materials in architecture in his book *The Eyes of the Skin,* which argues for a consideration of architecture as a full-body experience as opposed to a predominantly visual one. The ability for wood to activate a number of senses is one reason for its use around the world and in particular timber-based societies such as those in Scandinavia, Japan, and North America. The subtle creaking of wood floors, the hollow echo of a cabinet door closing and the feeling of a worn and weathered oak column are endearing moments in many of the homes and buildings we inhabit. This desire for a return to a sensorial understanding of architecture is echoed by Kenneth Frampton in his essay *Towards a Critical Regionalism*, in which he describes the passage through Alvar Aalto's Saynatsalo Hall as an orchestrated tactile experience with the sound of the wood floors and the touch of the wood railings playing a central role. He contrasts this to a Western tendency to consider visual perspective as the primary mode of navigating and understanding space.

In addition to its sensory qualities, the cellular and chemical composition of wood also mean that it is not an inert material, and is subject to degradation through time. This might come in the form of physical wear and marking from use, greying from UV exposure, patina from natural and human oils, and warping and deformation from moisture or heat. These might be seen as detrimental aspects of the material, but might also contribute to its humane and transient qualities. George Baird, in an introduction to Alvar Aalto's work, recognizes the impression in Aalto's buildings of 'having been aged in advance', a result of using materials such as wood, which are imprinted by the world around them, and actually seem to mature and grow better with age and use. Wood also has strong cultural associations to ideas of fire, hearth, and home. It was the primary fuel for heating and cooking for millennia and continues to be used in many rural areas. Many homes around the world also use wood as the primary building material because of its ease of use and availability.

9.2 12 wood blocks of local species found in Cambridge.

9.3 Holding the blocks. The blocks are a tactile tool for understanding the differences in wood properties such as grain, texture, colour, weight, and smell.

Today, the use of wood as an expressive and sensory-rich material is maybe at risk, as evident in many of its contemporary uses and applications. This is the result of many global trends, including the global trade of lumber, the increase in manufactured and heavily processed wood products, and the loss of traditional craft knowledge in favour of mass reproducible methods of making. There seems to be growing distance between the designer and the material, leading to an increasingly generic and insensitive form of use. How might a deeper understanding of the growth of wood, its material qualities, and the crafts used to alter it contribute to a richer and more honest approach to its use in architecture?

Wood Blocks

A collection of off-cuts from around Cambridge reveal the unique qualities of local woods. I cut these blocks into bar shapes, approximately 1.25 x 1.25x 5.5 inches, creating a common form for comparison. The bars are easily grasped using our hands, and we can bring these close to our heads to look, smell, or hear, inviting us to experience the texture, colour, grain, sound, and weight of each.


Colour

Chemicals, such as flavinoids and tannins give different woods there unique colours. Some might have earthy colours like the purples and greens seen in walnut, to the reddish tones of red oak and some pines. These colours change over time, sometimes darkening with exposure to UV, or can be completely changed with oils and stains. Outdoors, the sun and weather can cause many woods to turn to a silvery grey.

Grain

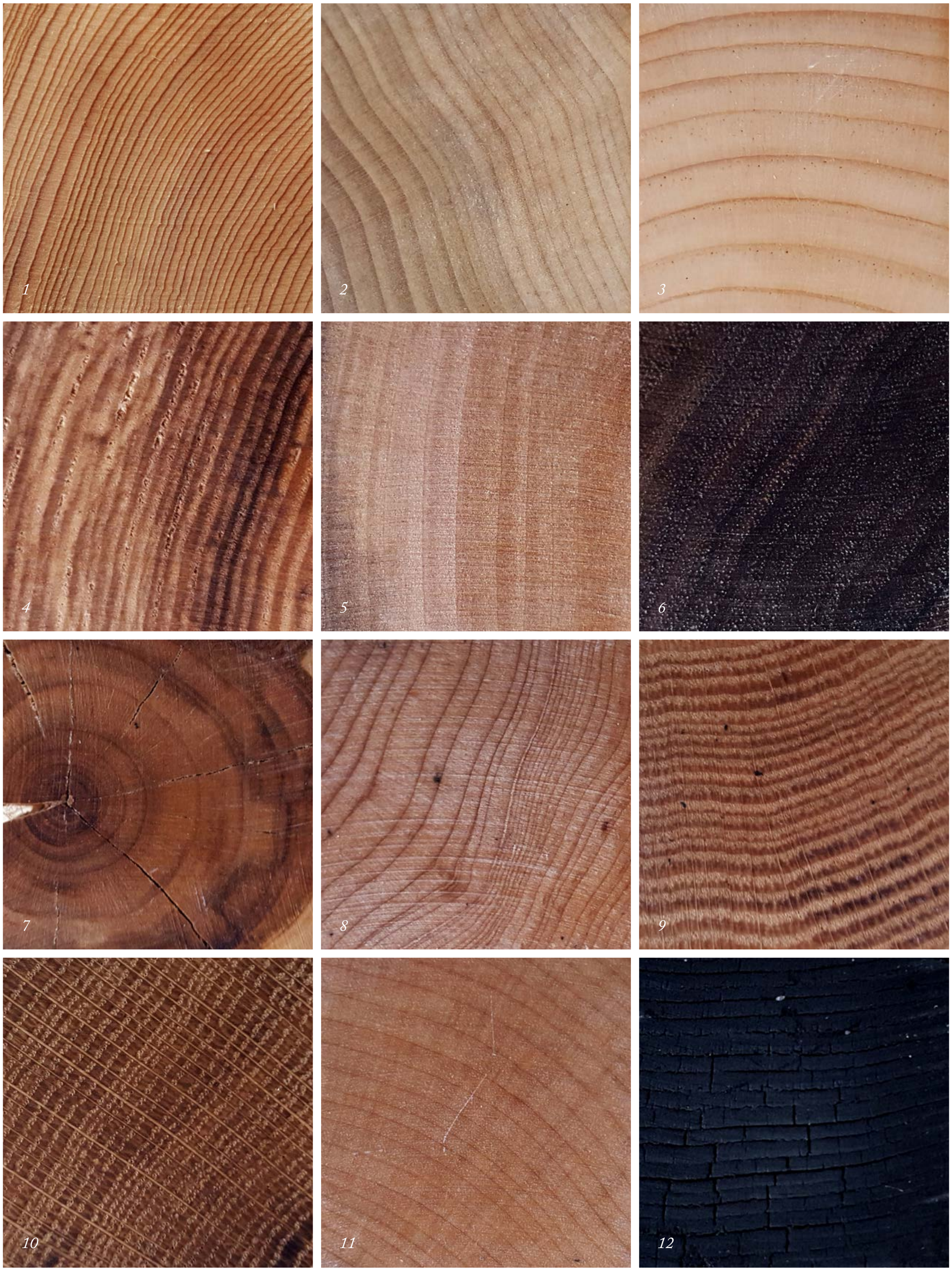
Grain is the pattern and orientation of the surface of the wood caused by the arrangement of the wood fibres. It is crucial factor in the workability of the wood, as the planing blade or saw respond and react to the changes in grain. The end-grain, or the grain of the wood when cut perpendicular to the direction of the fibres, exposes the rings of the tree, and is the most resistant and toughest direction to cut along. The face grain runs parallel to the fibres, and is much more easy to cut or saw along. How the wood is sawn and milled determines the grain that is visible. The highest value wood products are cut perpendicular to the rings of the tree, revealing the layers on the face of the wood.

Fragrance

Woods can be fragrant, sometimes in pleasant ways and sometimes not. It is one of the most memorable characteristics of the material. The floral smells of pine and cedar can remind us of cabins and saunas. The tannins in oak can bring back memories of wineries and cellars, where the humidity amplifies the scent. The smell of burning wood brings us back to warmth of a hearth or campfire. These different fragrances are again due the chemical composition of the wood. This scent can diminish over time but might release again if the wood is recut or sanded.

9.4 End grain of wood blocks.

1 White Pine
2 Tulip (Poplar)
3 Eastern White Cedar
4 White Ash
5 American Elm
6 Black Walnut
7 Black Cherry
8 Yellow Birch
9 Red Oak
10 White Oak
11 Hard Maple
12 Charred White Ash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Weight

The weight of wood can completely change the feeling of piece of furniture or object. Weighty woods, like oaks and walnuts, can add a feeling of solidity and heft to a building or piece of furniture, while light softwoods, such as pine and cedar might be good for temporary structures or movable furniture. These weights vary greatly, with a heavy wood such as white oak weighing around 750kg/m^3 compared to eastern white cedar weighing less than half this at 350kg/m^3.[1] The weight would be crucial when designing for wood structures.

Hardness

Similarly to weight, hardness plays a role in how we experience the wood. Some woods, such as hickory, are extremely hard, and are used for baseball bats, wheel spokes and tool handles. Others, like spruce or cedar, are so soft they can be easily indented with a finger nail. For reference, shagbark hickory, one of the hardest local woods, comes in at 8,360 N on the Janka hardness scale, while eastern white cedar comes in at 1,420 N.[2]

Workability

The workability of wood relates to many of the above physical characteristics and how they respond to the tools and techniques that are use in wood craft. The grain, density, hardness, and fibre structure all play a role in the workability of a wood. In Ontario, we have extreme weather variations between winter and summer. This means the tree rings are more pronounced, with the softer and light coloured earlywood contrasting with the dark and thin latewood. These variations make these woods more difficult to work than tropical woods, which grown consistently all year and might have no discernible late and early wood.

9.5 Face grain of wood blocks.

1 White Pine
2 Tulip (Poplar)
3 Eastern White Cedar
4 White Ash
5 American Elm
6 Black Walnut
7 Black Cherry
8 Yellow Birch
9 Red Oak
10 White Oak
11 Hard Maple
12 Charred White Ash

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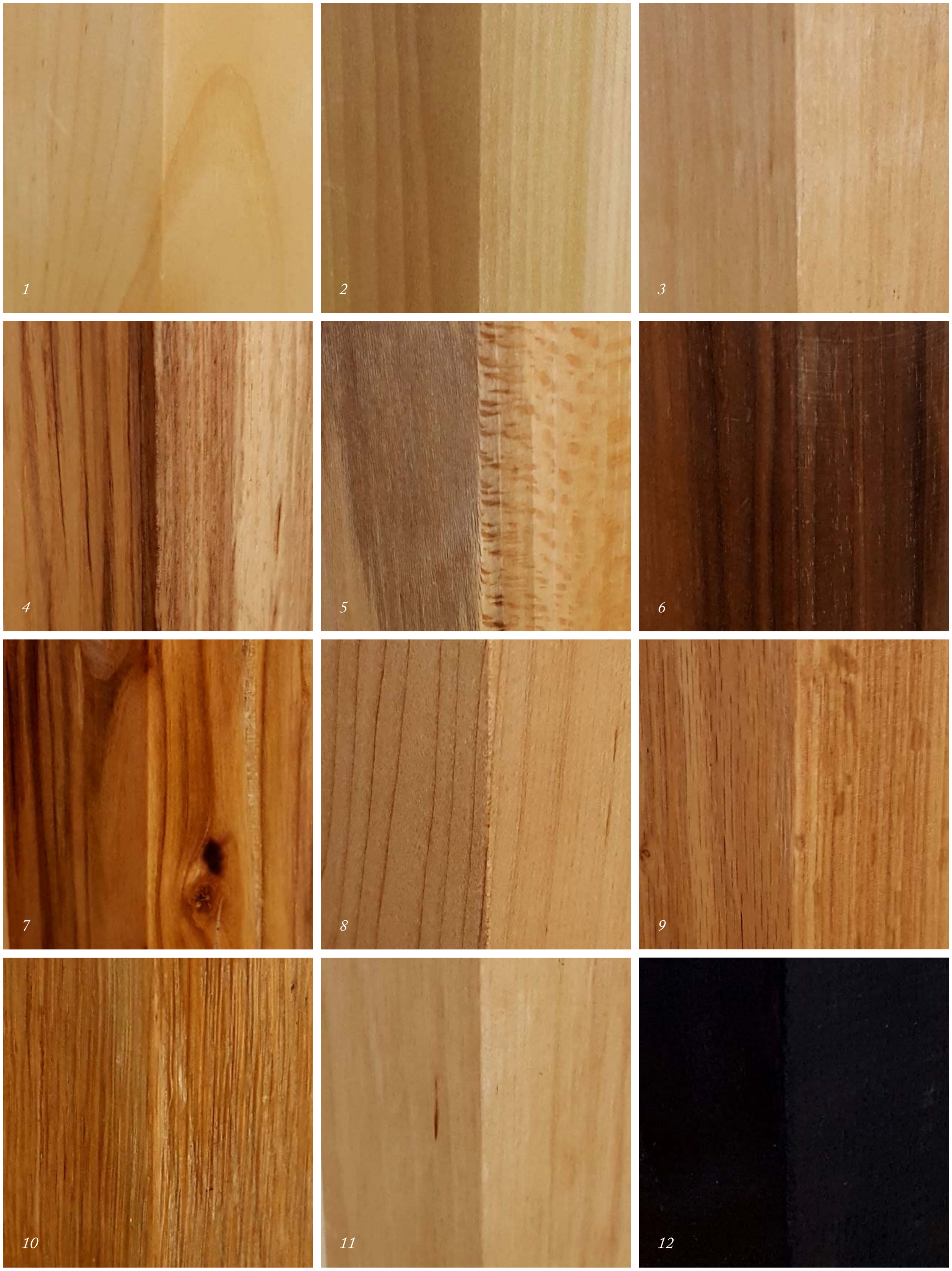
1 *Northern White Cedar, <https://www.wood-database.com/northern-white-cedar/>, accessed on June 2018.*

2 *Shagbark Hickory, <https://www.wood-database.com/shagbark-hickory/>, accessed on June 2018.*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Crafting

10.1 Detail of dovetail joint on white oak chest.

The transformation of trees into wood is only one half of the story. In the hands of craftsmen, artists and builders, the raw material of wood continues its journey and transformation into artifacts and architecture. The material is cut, bent, drilled, chiselled, sanded, stained or otherwise worked in a multitude of ways around the world. In the best of cases, this work can enhance or amplify the innate qualities of the wood, for example by cutting the wood in a certain way to expose interesting grain or colouring.

The tools and techniques used to shape wood have a significant effect on the aesthetic and structural outcomes of wood buildings and products. These tools have become increasingly complex, and follow closely a more general arc of human tool use from basic tools available locally to sophisticated machinery with components from around the globe.

In his book *Wood*, Joachim Radkau describes the earliest known wood implements found in 1995 in a coal mine in Schöningen, Germany and attributed to Homo Heidelbergensis, a species of extinct archaic humans. These spears, dating back 330,000 to 300,000 years ago, were made with remarkable craftsmanship and would have been made using other stone and wood tools.[1] This use of stone implements to fashion wood continued for thousands of years, even continuing in certain indigenous cultures in Canada up until the arrival of Europeans. Hilary Stewart explains that the stone or bone-headed adze with a wooden handle and bound with cord, was the most common tool of the Northwest Coastal people. These adzes came in many different sizes and shapes, used for different purposes, and in combination with stone chisels, wedges, and knives provided a large array of woodworking techniques. The use of these tools was a treasured tradition, and passed down from generation

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1 Radkau, 23.

to generation, with small advances along the way. One remarkable aspect of this type of working is the tool marks which appear on every surface of the buildings and artifacts created. In some cases, Stewart explains, the object or building was not considered complete until every surface had been dimpled and decorated by the craftsman's tool. These people also developed ingenious ways to work with the wood in it's natural state. The practice of steam or wet bending allowed them to create complex curved shapes which maintained the strength of the timber's grain pattern.

In places in which metal use had become widespread, such as Europe, Asia, parts of Africa and South America, new tools were created which were superior to the stone tools. Metal saws, axes, adzes, chisels, and planes became the norm in these places, and provided a level of consistency and precision in the use of wood which stone tools could not match. The toothed saw allowed for the fast cutting of even hardwood timbers. This was predominantly used in the form of a framed saw and later a pit saw, which required two people to operate. Steel tools were also advanced in Japan, where extremely sharp edges were required to accurately and cleanly work with local wood species such as Hinoki. The use of hand tools continues today in bespoke woodworking but is not common in large-scale production.

With hand tools, the maker has an immediate and intimate experience of the wood he is working with. Richard Sennett, in *The Craftsman*, describes the human grasp as one of our defining features, with opposable thumbs and versatile fingers allowing us to firmly hold a variety of objects.[2] These tools are often held directly in the hand, and then struck, pulled across, or twisted into the wood or other material. Some materials, such as clay, can be worked directly by the hand. Others, such as wood, require tools to meaningfully alter. Sennett argues, that this direct physical connection between the hand and the material creates a type of embodied learning experience, which is amplified by repetition. Master craftsman, who have spent thousands of

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2 Sennet, 150.

10.2 A worker sands a piece of a chair in a workshop in Wallenstein.

10.3 Chair templates hanging at a woodworking shop in Elmira.

10.4 Maple chairs stacked and ready for staining.

hours working with the tools, have a deep knowledge of the material which is not always apparent to them, but is embedded in their bodies and neural pathways. In this way, a woodworker might have a sensitivity to the grain of wood, its resistance, and a fine understanding of the flatness of a board through only touch. Coincidentally, as described by Frank R. Wilson in *The Hand*, the sophistication of the human and primate hand is directly related to its evolution amongst the trees of Africa, with complex grasping, climbing, and hanging motions needed to survive and thrive in that environment. These hands, being our primary appendages for interacting with the world, have developed highly sensitive muscles movements and robust nerve interaction with the brain.

Before motor powered saws, wood was felled and resawn using large hand saws sometimes with one person on each end pushing and pulling in tandem. According to Ken Drushka, the introduction of water powered saw mills were a first step in the automation of timber use. These mills were built near rivers and streams where the lumber was floated in large rafts from the felling site. In the mid-1800's with the rise of steam power and the circular saw, these mills were able to move away from rivers further in land and were instead fed by locomotives and tractors. The circular saw and chainsaw also made the process of felling timbers more efficient. Soon electric powered machines were revolutionizing wood craft and construction. This evolution in tool use went through a further evolution with computer numerically controlled (CNC) devices and later, robots such as KUKAs which allow for greater degrees of freedom in the milling of wood.

All of these machines offer high degree of precision and speed if used correctly, and although they arguably cannot match the seasoned hand of a master craftsmen, they do make wood craft and construction available to a much larger demographic including inexperienced users. These tools largely remove the embodied knowledge present in hand craft, or at least abstract it by varying degrees. Power saws, planers, drills, and routers are still subject to the density and grain of the wood, but to a lesser degree. The operator generally can feel the resistance, but not in the same way as directly working the wood. Machines such as CNC and robots require almost no interaction between the person and material other than loading it onto a bed or substrate. Interestingly, these machines also deal better with homogeneous and consistent materials, such as plywood and MDF, as they can be consistently routed and programmed. The idiosyncrasies and defects present in most natural unprocessed wood are more easily dealt with by the sensitive human hand and brain, but no doubt machines can be programmed to do this also.

Two Boxes

I continued tracing the life cycle of wood from the forest into the workshop, hoping to gain a tactile understanding of the material by working with it directly. Following the transformation of forests and trees into wood materials gave me the valuable insight that trees are subject to macro natural forces such as geography, climate and disease but also human forces such as urbanization and logging. At a smaller scale, we continue to shape the trees by cutting, milling and seasoning the wood, bringing out certain properties suitable for our uses. We then take this raw material and manipulate it further through craft. Following this path led me from the forest and sawmill to the workshop, where I endeavoured to work with wood at various scales, starting with a small chest, followed by a series of furniture pieces for a community group, and a finally a collective design and build project.

10.5 Two white oak boards cut in half to create four pieces, as bought from the local wood supplier.

10.6 The planed surface of the board reveals ray flecks. These are visible when some species of wood are quartersawn, and are wood cells which run horizontally from the centre of the trunk to the bark, in contrast to most cells which run vertically through the tree.

The first two projects, the chest and the stools, explore the different modes of craft, one focusing on the use of hand tools in the making of a one-off object, the other on a more repetitive process for a number of identical objects. The projects show how craft might occur in different ways, using different tools and techniques, with very different outcome in terms of quality, level of engagement and enjoyment in the process of making.

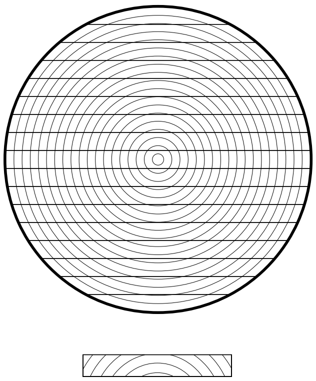
Box 1: Oak Chest

The first project, a small chest, was a one off piece designed and made to be durable and solid both in material and construction, to last for a lifetime or longer. An object to enjoy and grow old with. Many of the objects we might find today are not designed with longevity in mind but instead are designed to look good at the lowest cost and therefore sacrificing either material or technique and craftsmanship. I wanted to put time and effort into this box so that it might be enjoyed and used for many years to come.

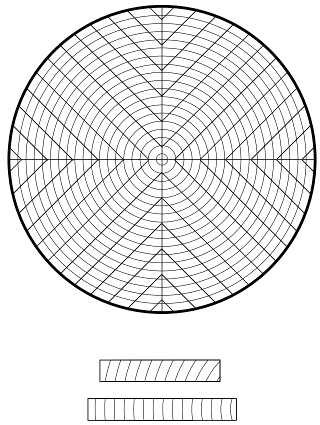
The first step in building the box was choosing the wood. Many local woods would be suitable for this, but I wanted a wood which was durable and long-lasting, weighty and yet not impossible to work by hand. This ruled out the soft woods, most of which are easily marked and dented, and whose joints might change shape with use and slowly come apart. Visiting the local wood retailer, I was drawn to the weight and solidity of the red and white oaks. Oaks have long been a symbol of longevity and strength in many cultures including. This reputation might come from the age of the trees, with many living for hundreds of years, and the strength and size of their trunks and branches.

Once I knew I would like to work with white oak, the next step was choosing the right boards. I knew I wanted the wall of the box to be thick, between 1/2 and 3/4 inches. This meant I would need at least a 4/4 board which is equal to 1 inch, which after planing and sanding would hopefully fall within the desired thickness. I also wanted the grain of the box to wrap around continuously on all 4 sides and to be continuous form the body to the lid. This means I would have to use only 1 board for the 4 sides of the box with a height of 8 to 9 inches. It was also important to choose a board with no knots that would make it difficult to plane or cut joinery into. Choosing the board, approximately 10 inches x 5/4 inches x 9 feet, I asked the shop to cut it into more manageable 4 1/2 foot lengths. I also found boards for the lid and floor of the box, which I planned to bookmatch along the length of the box.

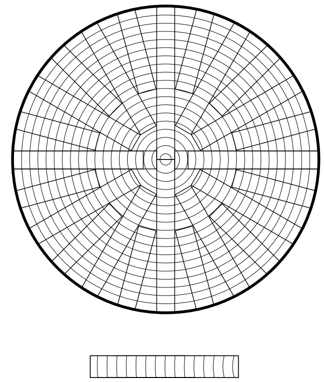
Machine tools were used in the initial planing and edging of the lumber, forming the close to final shapes of the boards. This process might have been completed by hand, but given time constraints I decided to spend my time learning joinery. This next step, creating the dovetail joints for the box, was by far the most time consuming and most enjoyable part of the project. Dovetails are a traditional joinery method used for many millenia by many civilizations and noted for their tensile strength, or resistance to being pulled apart. The dovetails were first marked out onto the boards. I had to learn to use the Japanese dozuki saw, a very thin blade for precise cutting, and proceeded to practice for a few hours before starting the actual cuts.



Plainsawn



Quartersawn

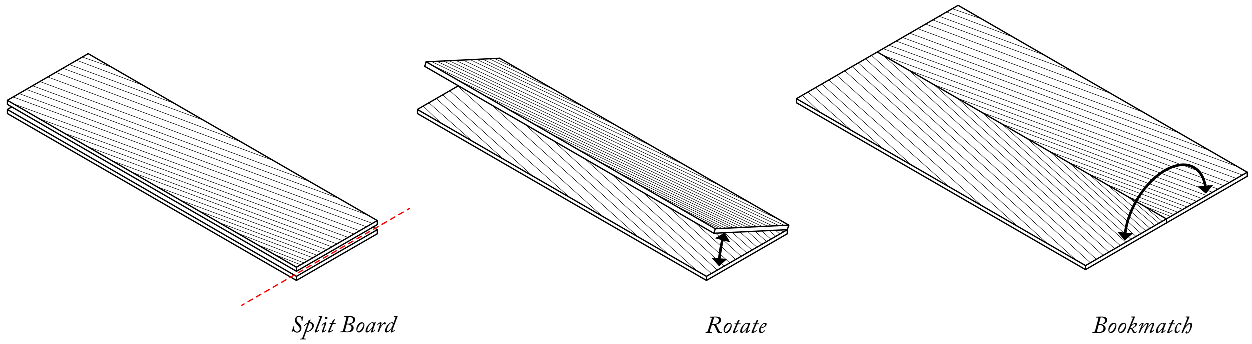


Rift Sawn

Log Sawing Types

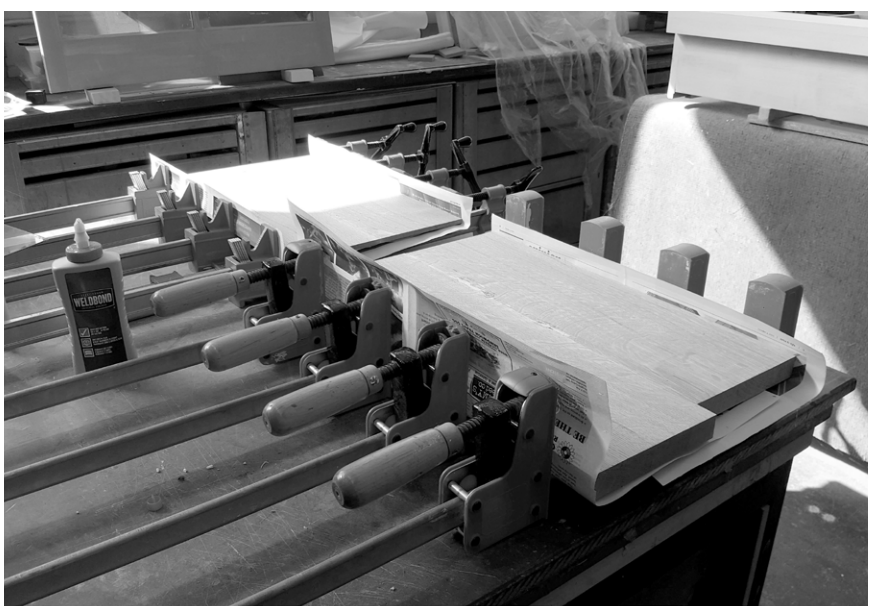
10.7 Plainsawn boards are cut parallel, producing a variety of boards with different grain patterns from perpendicular to parallel to the board with. Quartersawing produces a greater number of boards with growth rings perpendicular to the width of the board. This type of grain is desired for its consistent deformation over time and for the tight vertical bands of its grain. Some species such as oak present their ray flecks best when cut in this fashion. Rift sawing further improves the quality of the boards produced but results in much wasted material.

10.8 Plainsawn oak face (left) and quartersawn oak face (right)

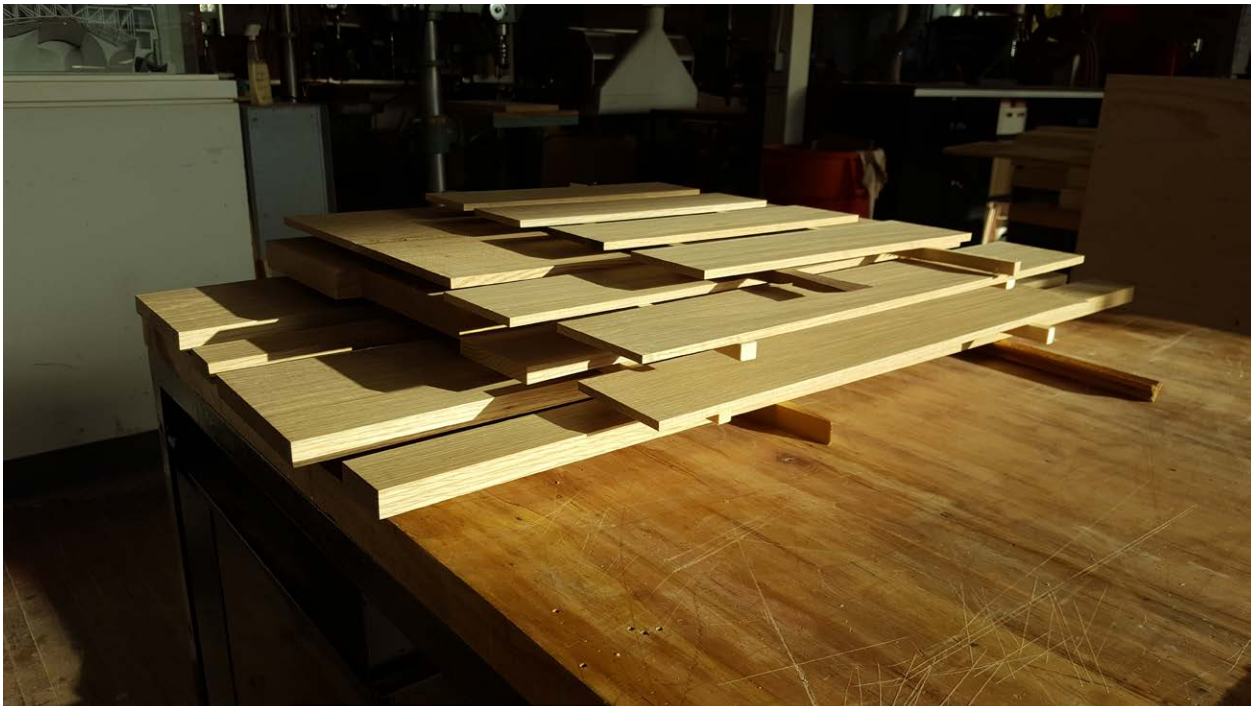


Bookmatching

10.9 Bookmatching involves splitting a single board into two pieces, opening the boards like a book so the two faces which were once touching are both now face up. This creates a near symmetrical grain pattern on the surface of the wood. Below, the bookmatched lid and floor of the box are glued together before further milling, sanding and finishing.



10.10 Bookmatched boards being glued together

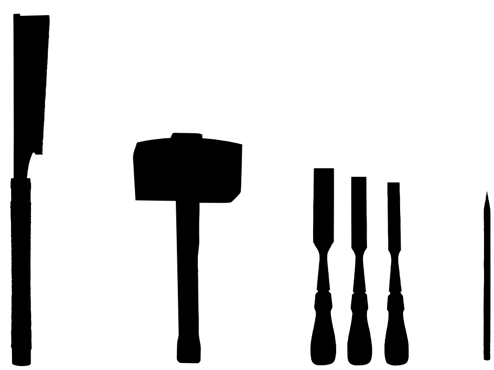


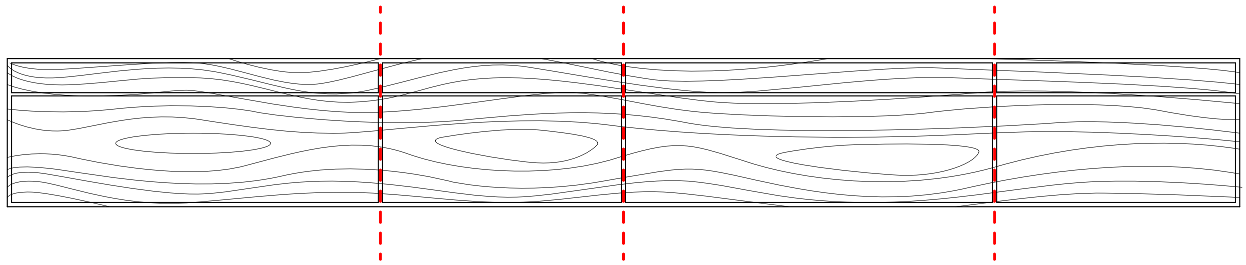
Stickering

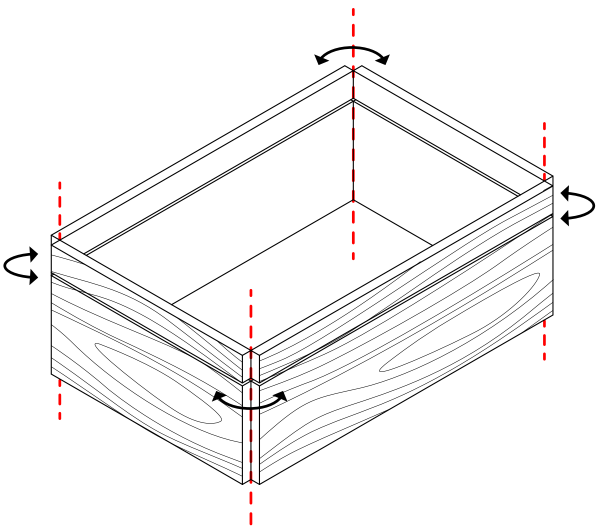
10.11 Planed boards stacked with stick spacers when not in use. The sticks let air flow all around the boards, allowing for even drying to prevent deformations.

Tools

10.12 Handtools used to cut the dovetail joints including a dozuki saw, a mallet, chisels and pencil for marking.

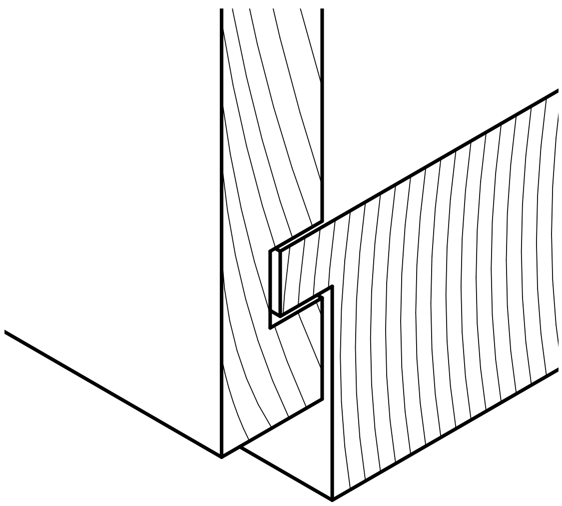




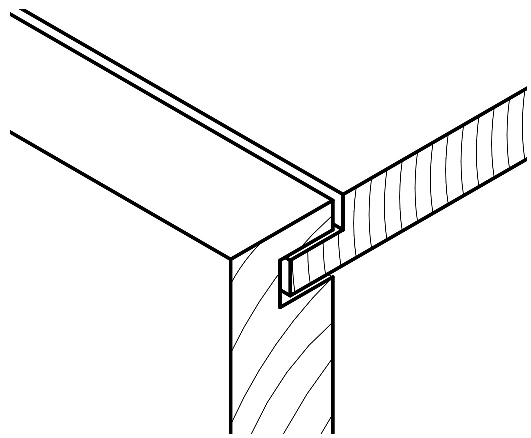


Continuous Grain

10.13 The walls of the box and lid are cut from a single large white oak board. These pieces are then rotated to form the box, resulting in a continuous grain pattern wrapping around the box.



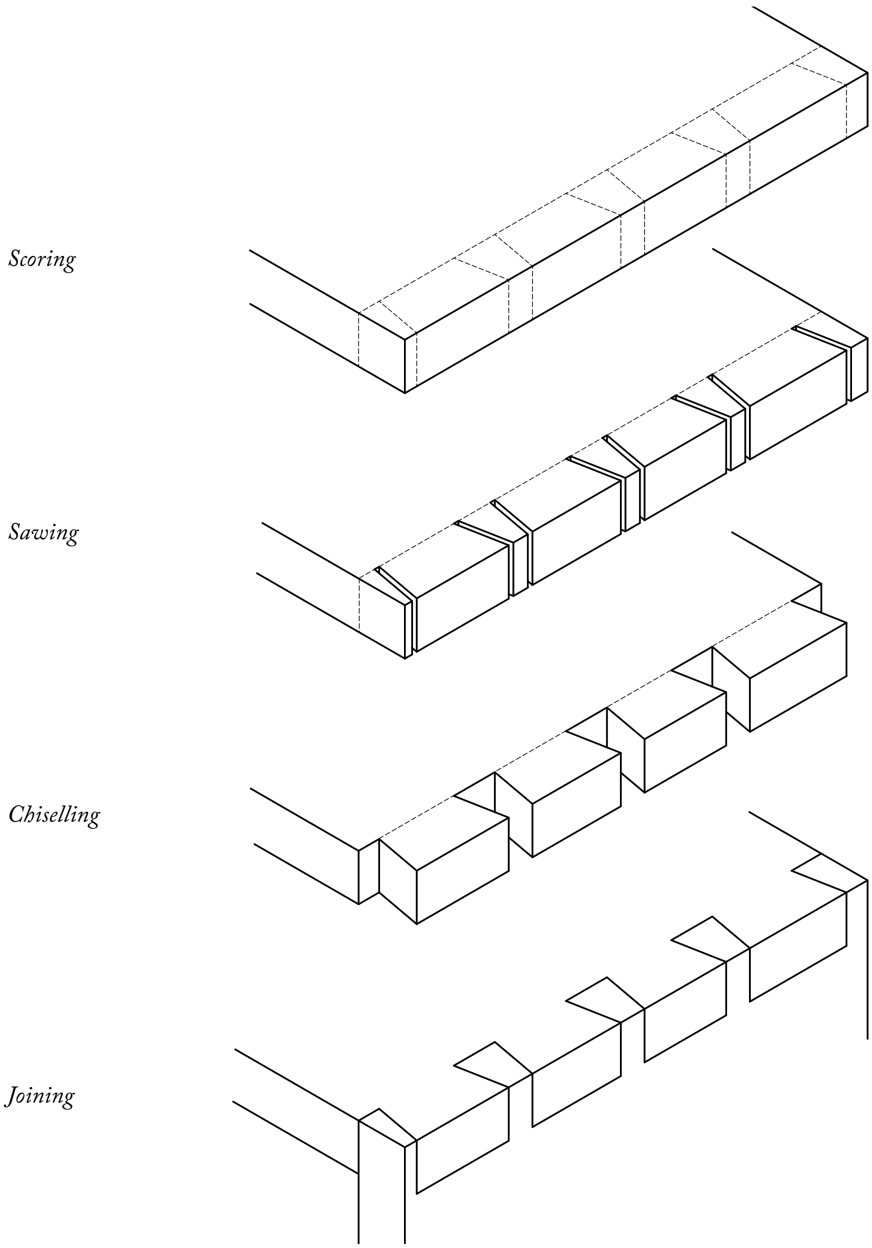
Expansion joint between walls and lid



Expansion joint between walls and floor

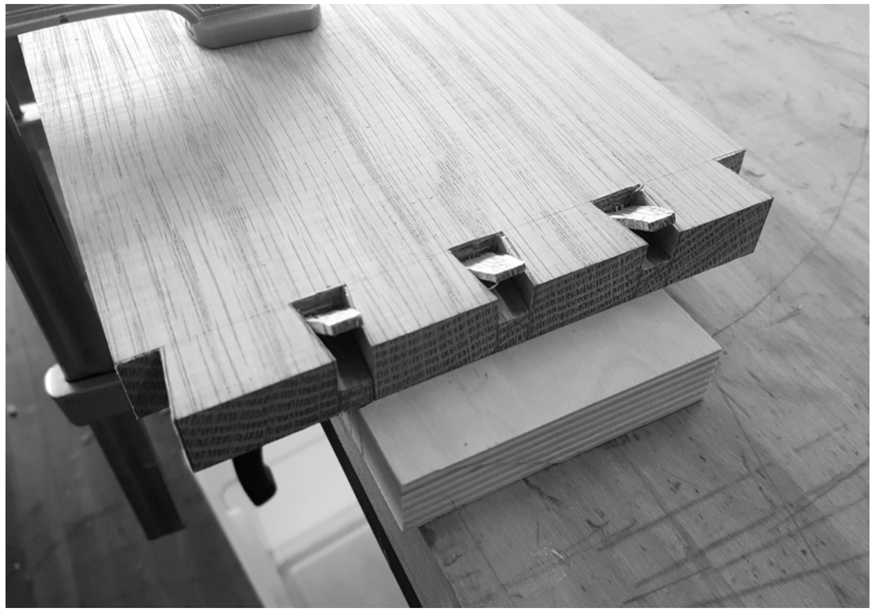
Grooves & Rabbets

10.14   The lid and floor of the box are inset into the walls of the box using grooves and rabbets. These joints are designed with some tolerance for expansion and contraction which occurs with changes in ambient temperature and humidity.



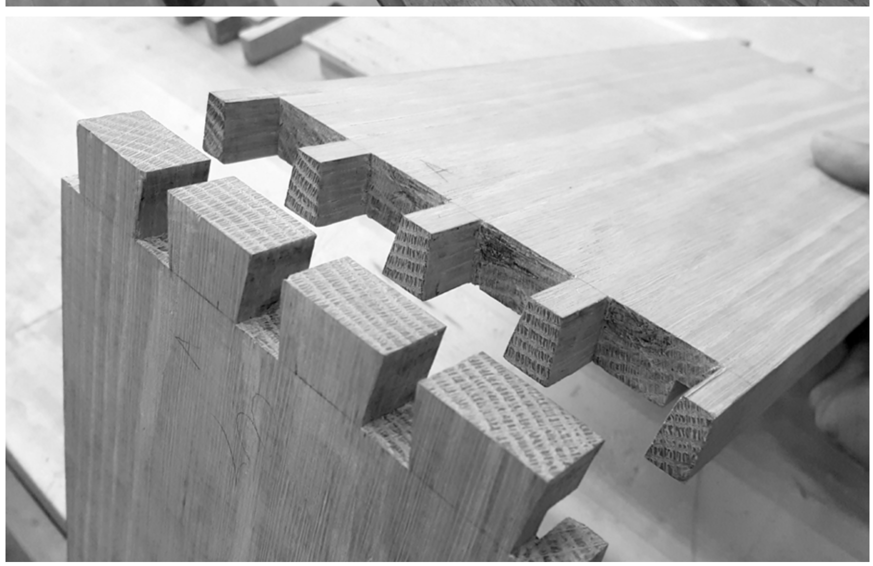
Dovetail Joints

10.15 Making the dovetail joints involves a number of steps including scoring, sawing, chiselling and joining the pieces. Each step requires attention in order to achieve a tight fit.



10.16 Sawing and chiselling tails into the milled boards.

10.17 Chiselling the pins in the adjoining boards.



10.18 Test fitting of dovetails

10.19 Finished chest with tung oil finish

10.20 Lid of box with bookmatched faces visible

10.21 Oak chest

Any major mistakes on the final pieces might mean they are unusable and that work would be wasted. The cuts went smoothly, but required concentration, patience and a steady hand to complete. Each cut was slightly different than the others, with the blade being forced into a direction by the grain of the wood. Once the cuts were made, the portions to be discarded were scored with a blade and then hammered out with a mallet and sharp chisels. The tail portion of the joints completed, the next step was the pins. The tails were traced onto the edge of the pin boards and then similiarly sawn and chiselled. Finally the pieces were test fitted, the tails and pins refined with the chisels, and finally glued and assembled.

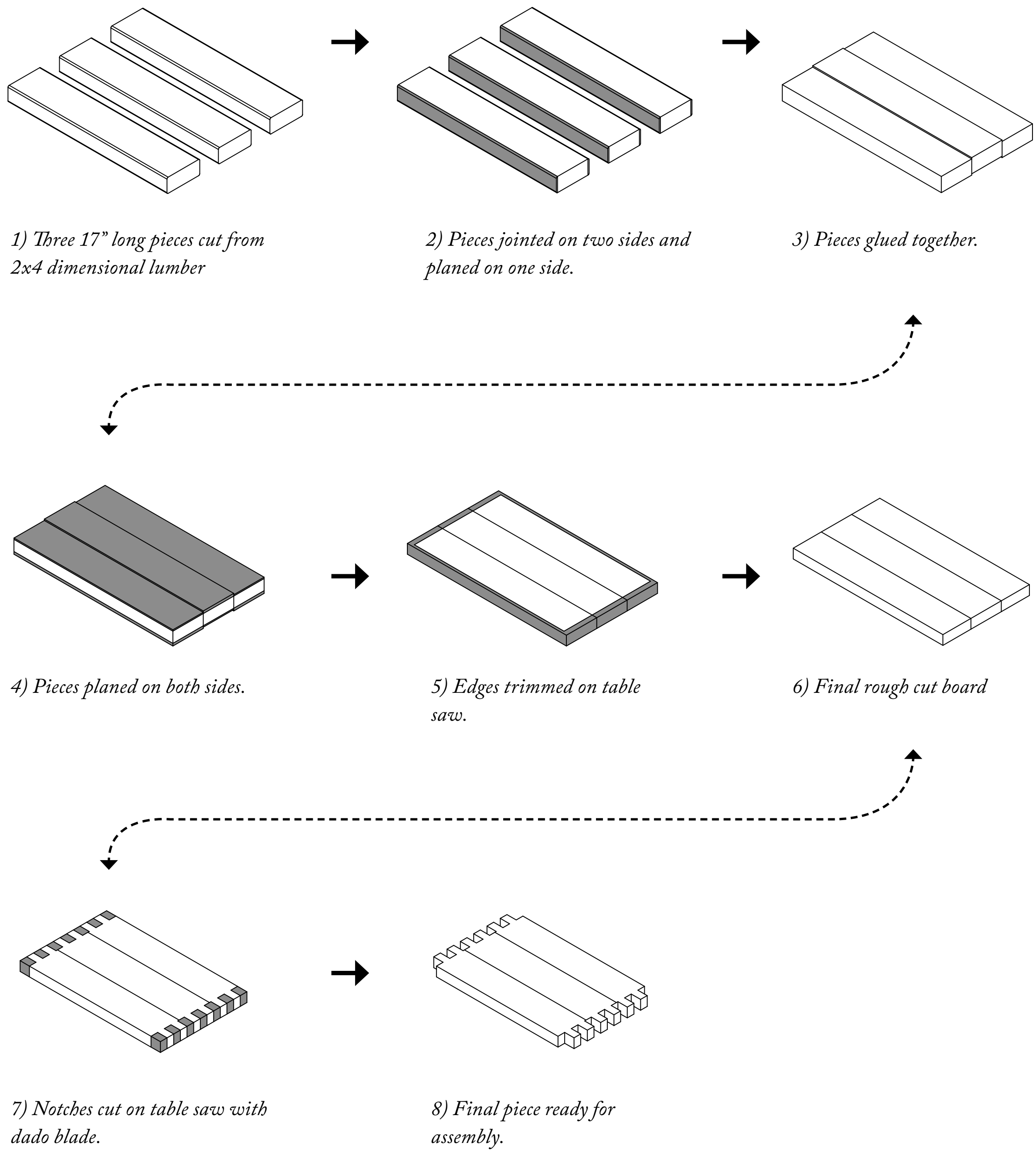
These dovetails might have been done by machine, but in learning to cut them by hand, I was forced to engage directly with the material, to learn its weight, density, grain, and resistance through my attempts to transform it with tools. This process was at times frustrating, but through practice became less difficult and more enjoyable. The attention and patience required in the cutting and chiselling was therapeutic and although took many hours, felt satisfying. The attachment and sense of accomplishment with the end result was a unique feeling. The box showed signs of being handmade, with many small variations in the size of the dovetails or the imperfections in the cuts. Finally the boards were sanded and then assembled into their final form. Multiple coats of tung oil created a durable finish to a unique box.

Box 2: Kayanase Stools

This project was commissioned as part of the Kayanase Studio, a design-build project by the University of Waterloo School of Architecture for the Six Nations of the Grand River under the supervision of John McMinn and Paul Dowling. Thirty-six stools were required, eighteen of which would stay indoors, and eighteen of which would have to weather and last outdoors. For the indoor stools, SPF dimensional lumber was chosen as it is available for a low cost, is easy to work, and is suitable for interior applications. For the outdoors, Eastern White Cedar was ideal for its ability to weather outdoors due to rot-resistant chemicals called thujones, which also give the cedar leaves their distinct fragrance. . The design of the stools took the form of rectangles approximately 16x12" with four sides joined with box joints. The rectangular shape of the stools allowed them to be rotated, with the taller dimension for use by adults, and the shorter dimension for children. The inner area could also be used as a small storage space for backpacks.

The stools were in very similar to the chest in size and shape, however the process and quantity required was far different, and a more automated process was used complete the large quantity with reasonable consistency. A finger joint detail was used to remove the need for screws and hardware to assemble the furniture. Due to the short timeline of the build, and the large quantity of stools, a table custom jig and a table saw with a dado blade was used to more easily cut the over 1000 slots for the 36 stools. This semi-automated process, which aims for quantity and consistency, is in distinct contrast to the intimate work of the dovetail joinery.

The process greatly sped up the time required to produce the pieces, and increased the consistency of the objects. However the experience was far more monotonous, with the robotic nature of pushing the joints through the dado blade for hours on end. The mental and physical practice of the hand cut joints was reduced to a machine-like repetition. This required very little feeling or intuition for the qualities of the material as the high-powered blade easily cut through the material with little feedback to the user. The work done by hand was far more engaging and satisfying then the work done by machine. The knowledge gained of the material was far more complete when working by hand and this knowledge is embodied in the sense that your body actually feels and understands the material intimately. This knowledge might not only be useful to the craftsmen, but also to the architects and designer. Understanding the material informs how it should and can be used, what applications it might be good for, how it can be joined and detailed, how it might transform over time and what aesthetic and experiential qualities it might elicit.



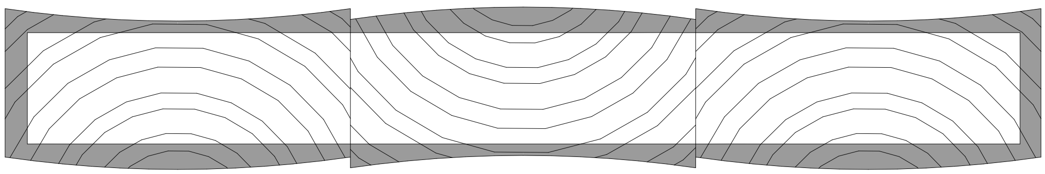
Component Production

10.22 The kayanase stool pieces go through a number of steps from the raw wood to the completed piece. Along the way, the boards are glued, jointed, planed, cut, and dadoed.

10.23 Cedar boards before milling

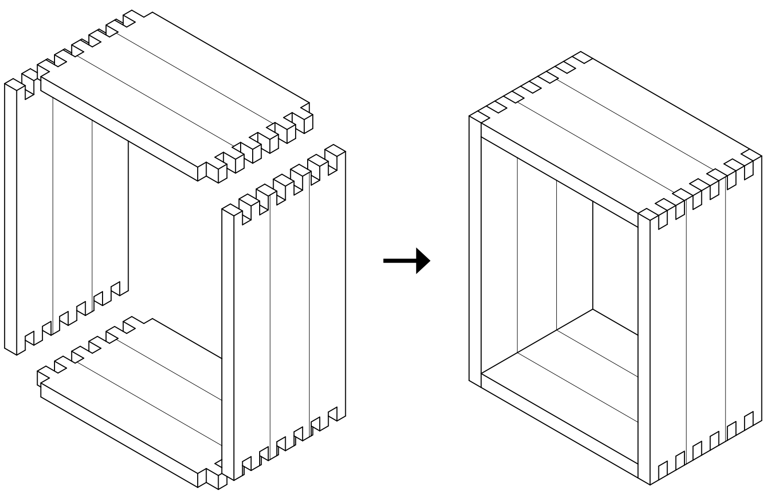
10.24 Glued up boards ready for finger joints.

10.25 Cutting finger joints on a custom jig.



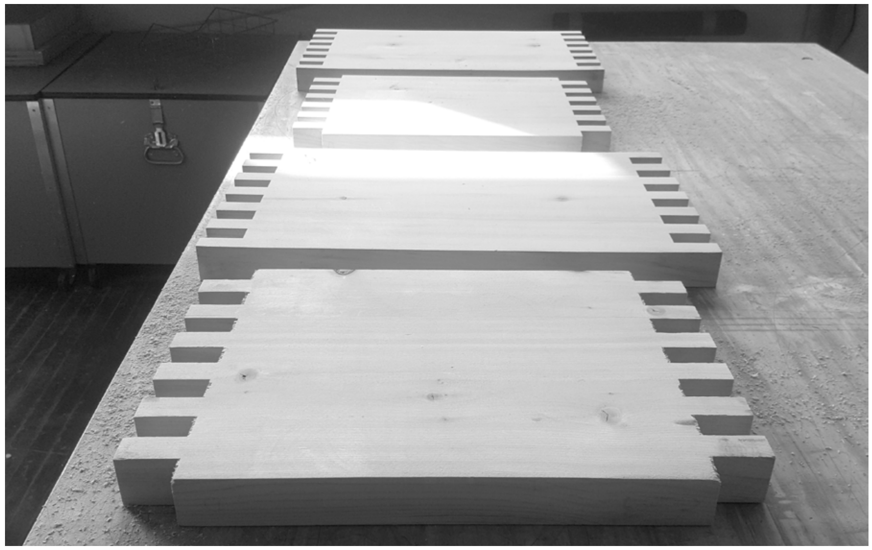
Alternating Grain

10.26 The pieces are alternated one up and one down. As the wood dries over time, the overall board will remain more straight than if all of the pieces were facing in the same direction.



Assembly of the Stools

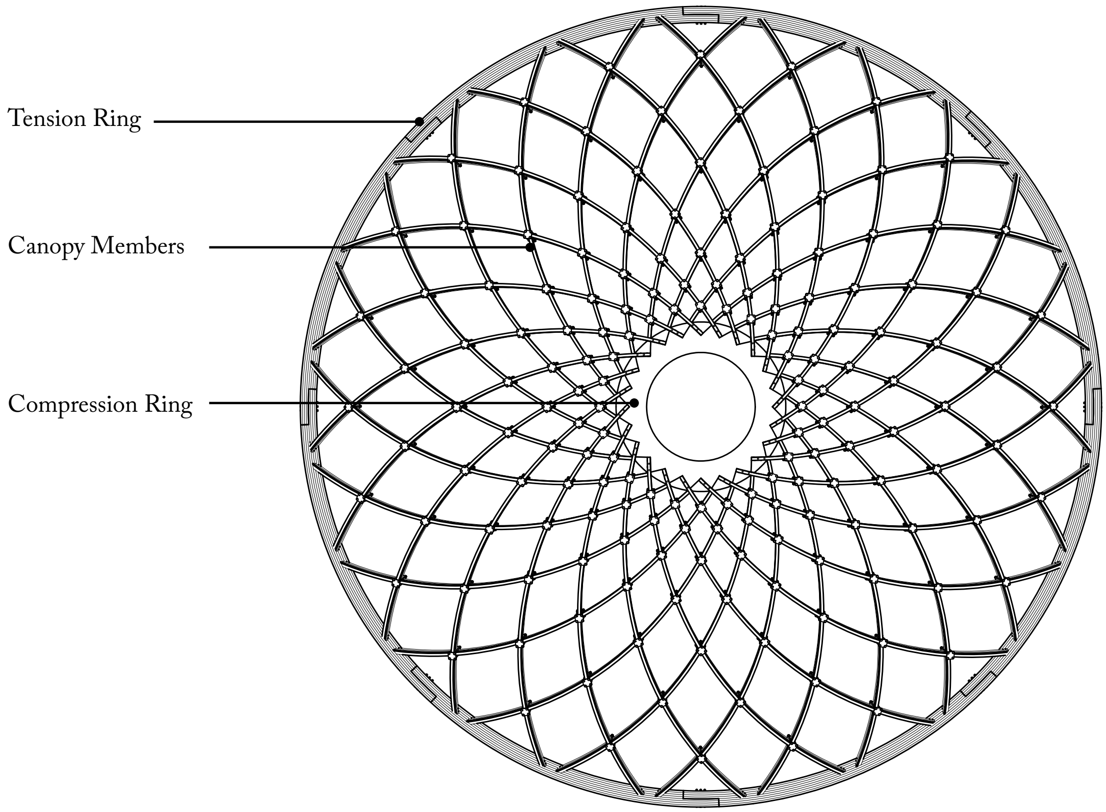
10.27 The four sides of the stool are dry fitted and then glued together

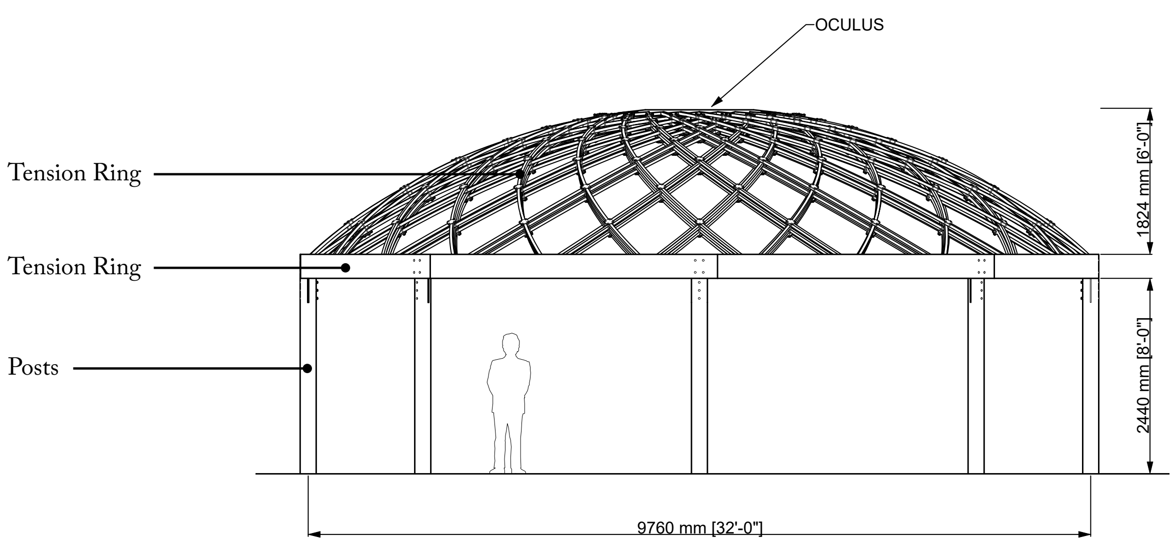


10.28 Stool boards with notches

10.29 Test fitting the joints

10.30 Assembled stools


Tension Ring
Canopy Members
Compression Ring


OCULUS
Tension Ring
Tension Ring
Posts
1824 mm [6'-0"]
2440 mm [8'-0"]
9760 mm [32'-0"]

Wood Structures

11.1 Plan and elevation of Grove Arbor structure with components labelled

The rich tactile and sensory qualities of wood that we appreciate are found not only in furniture and objects, but also at the scale of architecture from private homes to large public works. Buildings and spaces might make use of wood as a structural material, as an interior finish or exterior cladding, immersing us in built timber environments. From the building of indigenous longhouses, to the barn-raising traditions of Amish and Old Order Mennonites of Ontario, the construction of wood buildings can also become vital civic acts, with communities coming together to build for the benefit of many.

Wood as a building material has been used at many scales and many types of structure throughout history, from simple sheds to large civic buildings, bridges and towers. The craft traditions and architecture that evolve in a place are intimately tied to the species of trees that grow in the region as populations learn the best uses for particular types of wood or other tree products. As a material for building, wood has many beneficial properties including its strength, ease of use, relative lightness, and is a renewable resource which can be replanted after harvest. Some areas of the world have become renowned for their ability to use wood in their architecture, such as in Scandinavia or Japan, where timber use has been an integral part of their culture and has been carried through into contemporary construction practices. In Canada, and Ontario specifically, Indigenous construction methods have been practiced for millenia, and often use many parts of the tree including the wood, bark, roots, branches and sap.

The use of wood for large construction projects continued to be prevalent in the early 1900's when a series of large urban fires led to by-laws which limited the use of wood in large or tall structures. In the last few decades, there has been a resurgence in the use of timber materials for construction, largely due to the adoption of composite timber products such as Cross Laminated Timber, Nail Laminated Timber, Glue Laminated Timber and other manufactured products and further testing and innovations in the fire suppression. This renaissance in timber use is also a product of increasing awareness of the energy required to extract and the greenhouse gasses emitted in the process of creating materials such as concrete and steel. Timber, a material which acts as a carbon store, provides a useful alternative to these high embodied energy materials.

The use of wood in architecture also presents unique aesthetic and experiential opportunities. As a warm coloured material, wood can provide a strong contrast to the cool and hard materials such as steel, glass, and concrete. It is a material which invited touch, and often feels less hot or cold in extreme temperatures. As it is formed of once living cells, the variations in texture and grain create interesting patterns and forms on the exposed surfaces. Sometimes the wood structure is hidden, as in the case of light-frame wood where gypsum board is often used to entirely cover the structure, but with mass-timber buildings, this structure can be left exposed as larger members are able to withstand direct fire for longer periods of time. Wood structures are often assembled of many components which are connected together, as opposed to concrete which might be poured monolithically, and this again influences the aesthetic qualities of buildings and interiors. This joinery might occur in different ways. Traditional joinery methods might only use complex geometries cut into the members to mate two or more pieces of wood together. Indigenous structures often used some flexible string or rope to tie pieces to each other. More contemporary methods might use steel connections and bolts instead.

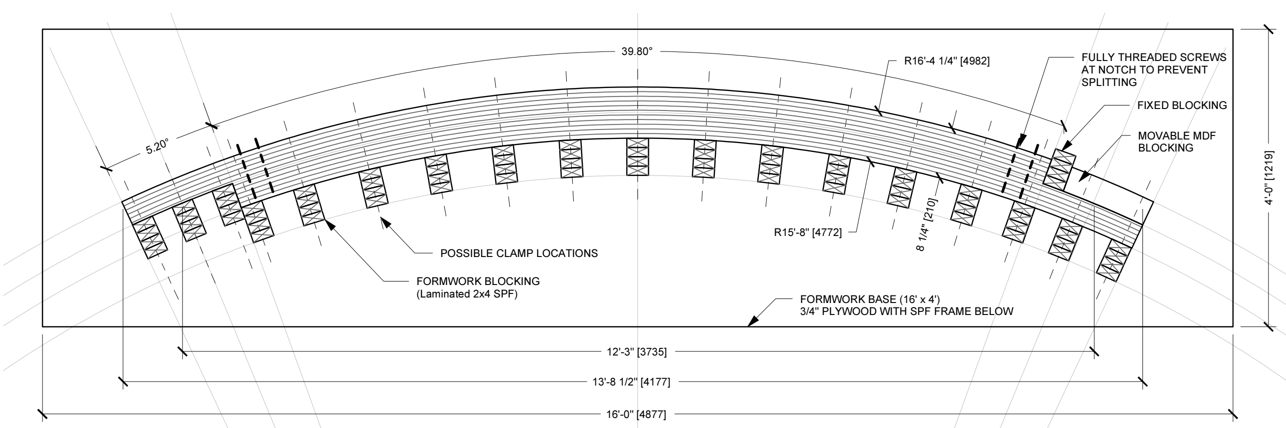
Grove Arbor

The Grove Arbor is a timber structure which was commissioned by the Mississaugas of the Credit First Nation who required a new pow wow arbor in a sacred oak grove at the heart of the community. The Mississaugas territory lies adjacent to the Six Nations of the Grand River First Nation, between

11.2 Testing a steambent piece of ash

11.3 3 pieces of wood. The topmost is a stick of ash wood, the second is steambent stick, and the third is a glulaminated ash member

11.4 A plan detail of form work and assembly of one of the tension ring members.



Hagersville and Brantford, Ontario. The project was undertaken as part of the Design Build program at the University of Waterloo School of Architecture and was conceived of as a collective project similar to the barn-raising traditions found in Ontario, where many might contribute to build something for the community, providing man-power to a collective endeavour.

The design began with a series of conceptual ideas which each utilized wood to achieve various shelter forms with openings for the users. The chosen design was a shallow dome supported on a series of posts, with the dome consisting of a series of spiralling members with an oculus in the centre, closely resembling dream catchers used in some aboriginal cultures. The final design consisted of eight posts secured in the ground to support the canopy, a large tension ring supported on the posts, a network of smaller members forming the curved canopy, and a central compression ring forming the oculus.

With the intention of using wood as the main material, one of the primary challenges was the creation of the curved members in the canopy as wells as compression and tension rings. For the canopy, a number of wood bending techniques were tested including dry bending, steam bending, and glue lamination. To accomplish this, a form work was made out of plywood and scrap wood blocks, which closely followed the curvature of the expected final geometry. For the steam-bending, A 1.5" x 1.5" x 8' piece of ash wood was first soaked in water overnight, then steamed in a PVC tube for up to an hour, and finally clamped to the form work and left to dry. For the glue lamination, a number of 1/2" ash strips were glued together and again clamped to the form work. The glu-lam members retained there shape much more when taken off the form, while the steamed members would spring back a few inches, making the final form less predictable. The dry bent pieces would immediately spring back and required huge force to form into shape. Glu-lamination was chosen as the method of choice for its relative ease and the predictability of the curvatures.

The species of woods used in the project were chosen for their practicality and appropriateness for the various parts of the structure. The posts, which would be in close contact to the ground, were constructed of eastern white cedar, which has very good rot resistance due to chemicals in the wood. The compression and tension ring were constructed in white oak, which although heavy, is stronger than many woods and also weathers very well outdoors compared to other hardwoods. Finally, the spiralling members were constructed in white ash, which bends well and is relatively inexpensive due to the emerald ash borer. The arbor was designed to be covered by a tensile fabric and so the ash members would not directly encounter ultraviolet rays, or direct moisture from snow and rain.

Given the small scale of the project, the components of the structure were designed to be carried and assembled with no machinery, and so were dimensioned and kept to weight limits that would allow the to be lifted and assembled in place. The larger tension ring was broken into eight parts which could be joined together on site. The project was an great example of transforming a simple concept into a built work through rigourous detailing and material testing.

Mending

Craft is not always about making new things, but might be about the maintenance and care of old things. The capacity to work with one's hands offers the chance to not just consume other people's work, but to create ones own, or to take something old and renew or re-purpose it. Solid wood is particularly good for refurbishing and renewing, as it might be worked with a few simple hand tools, unlike many of the composite wood products such as chipwood and MDF, which can disintegrate and fail with use. Today, with the availability and low cost of mass produced goods on the market, it is very easy to throw away what we have when it is deemed broken or out of order. And yet with some time and effort, what is broken might be fixed and take on a new life.

Thonet Chair

Walking in Cambridge one day, I noticed four chair legs sticking out of trash pile by a house. I was surprised to find a chair which I recognized as a Thonet design with its bentwood forms and elegant shape. I took this home and after some research I found that this was a Michael Thonet design of the no. 14 chair from 1859. This was not an original but one made by FMG or Fabryka Mebli Giętych (which translates to bent furniture factory in english) in Poland in the 1950's in European beech wood.[1] The chair was in visible disrepair with the original cane seat replaced by a round piece of plywood, a deep split in the chair back, and staining on the legs where they meet the ground. I wasn't too sure if it could be fixed, but I took it anyways and decided to find out. Thonet bentwood chairs are highly regarded by designers for their simplicity and comfort and were one of the first to use mass production techniques for furniture starting in 1859. Their design and assembly were geared towards

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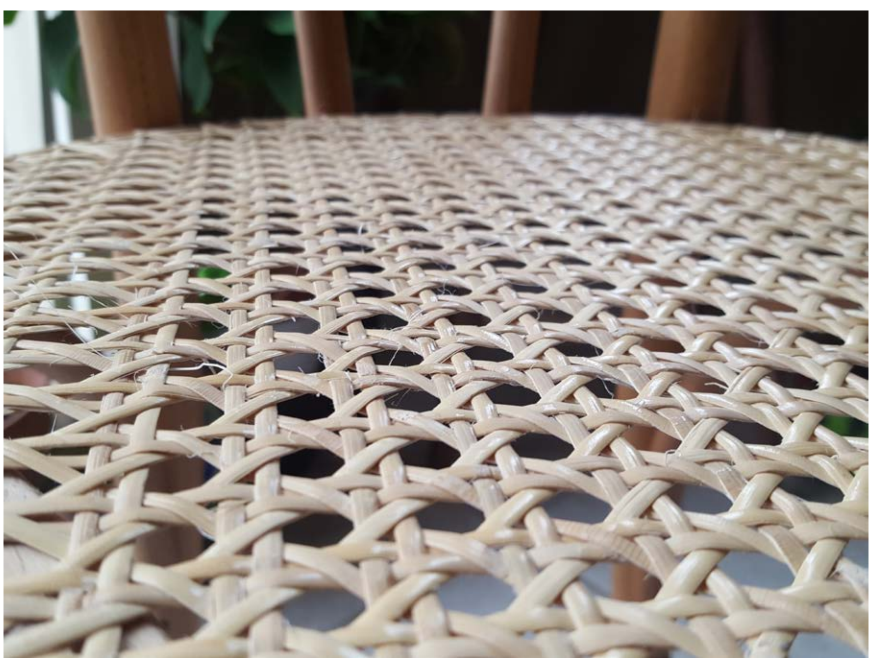
1 *Thonet – A Pioneer of Furniture History, <http://en.thonet.de/fileadmin/media/meta/presse/Basispressemappe/EN_Thonet_Company_Press_Kit_Jan_2015.pdf>, accessed on July, 2019.*

12.1 The european birch pieces of the chair after disassembly. These are the bentwood pieces that would have been sent to customers en masse for assembly.

12.2 Filling a screw hole which was not part of the original chair design.

12.3 American beech spliced into the original european beach to fix a large crack in the chair



12.4 Mended Thonet chair

12.5 Detail of the newly woven cane seat scalability in production, using repeatable pieces and metal fasteners. The extensive beechwood forests of Moravia, in current day Czech Republic, provided the Thonet factories with a light and strong wood that could be shaped after steaming, creating the iconic curved forms of the chairs. The chair became a staple of European households, restaurants and bistros selling over 50 million pieces over a 70 year period.[2]

I tried my hand at mending the abandoned chair. I first disassembled the chair, then removed the original lacquer coating and hand sanded the pieces down to their raw beechwood. The large crack in the seat provided the largest challenge. I tackled this by first cutting and sanding it out and intended on splicing in a new piece of wood to strengthen the area and return it to its original form. The original European beech would be difficult to find in Cambridge, but luckily the workshop at UWSA had a piece of American beech, similar in density, grain, and finish, and slightly different in colour. It would have to do. I cut a small piece from this, sanded one side flat, and then glued and clamped it to the original wood, finally sanding it smooth to the original curve. The original Thonet chairs had woven cane seats and so I also replaced this with a hand-woven can seat. Finally I reassemble the chair and gave it a soap finish a traditional Scandinavian wood finish where soap flakes are moistened and then applied to the chair in multiple layers. The result is a soft matte finish which can be easily reapplied over time.

Crafting in wood can teach us much about our own tendencies and habits. At times frustrating and difficult, we are forced to work with the material as best as we can, having patience with an inherently organic and changing material. The grain may start straight, but then changes direction and we have to respond with the hand and tool. Over the days the wood might develop a slight bow or other defect, and the once perfect fit is no longer ideal. These are the unexpected and sometimes frustrating moments in working with wood but which often lead to unexpected and artful works.

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2 *Thonet – A Pioneer of Furniture History, <http://en.thonet.de/fileadmin/media/meta/presse/Basispressemappe/EN_Thonet_Company_Press_Kit_Jan_2015.pdf>, accessed on July, 2019.*


ARCURI
FAUSTINO
BRAGA

Stewardship

13.1 Mature trees in Mount View Cemetery

In Cambridge, a white oak tree sits just a few hundred metres from the School of Architecture, towering over the local sculpture garden. You can see it's broad canopy out of the window at the end of the long hallway on the third floor of the school. This tree germinated in the 1870's, before we had cars or planes, and at roughly the same time the telephone was being invented by Alexander Graham Bell. The tree is far older than the School of Architecture building, which was built in the 1920's. Although not the oldest tree in Galt, it has been through its fair share of adversities, surviving a number of major floods including the flood of 1974, when the Grand River overcame its dykes and destroyed many of the homes adjacent to the river. After this destructive event, the city initiated a plan to raise the dykes along the river by five feet to prevent a similar flood. This would have meant removing the 100 year old tree for good. Instead, the city forester at the time, named John Kingswood, proposed constructing five foot tall walls encircling the tree, around which the new dykes could be bermed up. The plan worked and the tree survived and i if you visit the tree today you can look down through the panels towards the roots buried five feet below the ground. This tree was recently designated as one of the first trees protected under the Ontario Heritage Act.[1]

This story shows how significant our actions are for the survival and maintenance of the trees and forests which we make use of in so many ways. Our influence now ranges from the local to the global. Our need for wood materials means that more of our forests are becoming plantations for harvest. Agriculture and now increased urbanization have depleted the forest cover in many parts of the country, especially in Southern Ontario. In many ways architects are right in the middle of this ongoing negotiation between humans

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1 *The Heritage Tree Program. <https://www.forestsontario.ca/community/in-the-spotlight/heritage-trees/>, accessed on June, 2019.*

and forests. Our work relies on wood as a material for structure, cladding, finishing and furniture. The buildings and cities that we help design often come in conflict with natural systems, requiring the removal of existing habitats and trees. Is it the responsibility of an architect to learn about the natural systems that our work influences, and how might this change the way we design and the materials we use?

Walking the forests of Cambridge opened my eyes to the diversity of experiences for us to encounter. To witness the variations in colour of the leaves, or the difference in light quality under the hardwood and pine forests, or the protection of an oak tree in the rain, are all fundamental experiences which might inform our work. As history has shown, the woods and forests should not be taken for granted, and are only maintained or increased through a series of small human actions, such as planting a tree, or deciding to not cut down a tree, and larger civic actions such as forest management plans, or protective legislation. It's clear that each person plays a role. What role might architect's play?

At the simplest level, John Kingswood's proposal for the white oak is an example of how design might work with and not against a natural system. His intent was the maintenance and care for another living organism which was under threat. These types of design solutions extend to larger projects, such as the building of boardwalks and benches in the forest networks around Cambridge. These might seem mundane, but they offer a rich opportunity for people to interact with the remaining forests in the region. This type of course might be taken further, towards a more holistic approach to design education, where students engage with the site in a more fundamental way. One such project might involve working within a forest in Cambridge, harvesting and seasoning the wood on site, and using this material for community or education related projects on the site. The numerous forestry professionals, sawmill owners, and wood suppliers would make for a strong network of lecturers and guides. The goal of this type of curriculum would be a more holistic understanding of designing and living with trees and wood, and engendering a feeling of responsibility and stewardship in future designers.

This stewardship extends to the simple community acts that we might take part in. On sites such as RARE and Sudden Tract weekly walks are held, where people devote a few hours of their day to removing the invasive species which have taken hold in many parts of the region. These few hours each week can make a significant impact in allowing native species to grow and thrive, creating greater diversity and resilience within the ecosystem. Tree planting events take place in spring, aimed, at reforesting the region which has seen so much tree covered lost over the last 100 years. These community activities are not only beneficial to the natural systems, but they also create a way for students to engage with the people of Galt and perhaps develop a greater attachment and feeling of care towards the communities they live in.

14.1 Fall leaves in Victoria Park, Cambridge.

A Forest-Based Curriculum

Having started university with a rudimentary knowledge of wood from weekend trips to the big box, I was able to build up my theoretical and hands-on knowledge of wood through formal courses and projects as well as self-initiated studies and explorations. This process of learning about the material while also making objects, furniture, and structures was incredibly fulfilling and seemed a valuable experience which might be shared with other students and architects in some form. I began to consider how the scope of my personal studies and explorations might be formalized and formulated into a curriculum or course for students at the School of Architecture focused on the deeper understanding of tree and wood life cycles.

Timber use in architecture is currently undergoing a renewal with the application of mass-timber and light-frame timber in large-scale building projects. This is part of a larger effort to use sustainable and renewable materials for construction as issues of climate change become ever more urgent. Light-frame construction has been used for decades in single family homes and townhomes, especially in the suburbs of Ontario, however the use of wood in other building types has been limited. In 2015, the Ontario Building Code was amended to allow for 6-storey wood buildings, opening up possibilities for taller and larger wood buildings in the province.[1] These types of legislation changes and material innovations have the potential to make timber construction a common practice with the industry once again. Exposing future architects to the life cycles of these materials will give them a strong background from which to design and work with wood as well as participate in and think critically about the impact of their designs and buildings on the larger natural world.

1 *Canada Wood Council, Mid-rise Buildings, <https://cwc.ca/how-to-build-with-wood/building-systems/mid-rise-buildings/>, accessed on June, 2019.*

The School of Architecture in Cambridge sits in the transition zone between the Great Lakes-St.Lawrence forests and the Carolinian forests of Ontario, in a region rich with woodlots and forests and a strong history of wood use and traditions. These geographical and cultural features make it an ideal place for future architects to learn about timber practices. There are a number of courses at the school which already expose students to theoretical and practical aspects of wood use in architecture and design. The aesthetic and material aspects are explored in studio courses, structural analysis and detailing in structures courses, woodworking courses in the shop, and design-build courses which apply all of these practices into built works. However there is an opportunity for a course which exposes students to a more holistic view of the life cycle of wood, starting in the forests where the timber grows. With the increasing use of digital technologies in architectural practice, physical interactions with materials can become an afterthought. Architecture's goal is to create real spaces, and so an in depth knowledge of materials seems crucial. This course might allows students to think of materials in a different way, not something abstract as seen on a computer, but instead something real which is created by living forces over an extended period of time.

Precedents

The course takes its inspiration from a number of similar courses in Canada and abroad. These courses occur at many scales and budgets, but each has a similar goal of returning students to the physical realities of architectural practice in relation to particular environmental contexts or sites.

Design Build UWSA:

An graduate and undergraduate elective course run by Professor John McMinn and Paul Dowling which has resulted in the design and construction of a number of commissioned projects including the Kayanase pavilion at Six Nations of the Grand River, and Mississaugas of the Credit pow wow arbor. The course takes students through all project stages from concept design, design development and detailing, to hands-on construction. The course gives students an in-depth knowledge of wood use in design and construction and hands-on experience of working with the material.

Architectural Association's Hooke Park:

Hooke Park is a forest-based campus for the Architectural Association in the UK, which offers students the chance to study and work in the forest, while designing and building projects for the campus using materials harvested on site. The campus includes an on-site sawmill, storage sheds, and workshops with robotic arms and CNC's which are used to explore innovative ways of working and building with wood.[2]

Richard Kroeker:

Richard Kroeker is an architect based in the east coast of Canada, who focusses on local ecology, materials, and methods in his designs. He has contributed to a number of student courses focussed on local building practices and materials including a project with the Nova Scotia College of Art and Design and the Dalhousie University School of Architecture called Beaverbank, a small structure which uses wood materials from the site and traditional indigenous construction techniques.[3]

Ghost Lab:

This 2-week studio ran for 13 sessions ending in 2011 and was located in Upper Kingsburg on Nova Scotia's South Shore and run by Brian-McKay Lyons with students from the Dalhousie University School of Architecture. Beginning in 1994, the studios participants lived and worked on the land, with architects and multi-disciplinary practitioners, collectively designing for the first week and building for the next. The primarily wood constructions were rooted in simple construction methods and modest materials and are well-regarded for their relationships to the stark landscape.[4]

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2 *Hooke Park, AA School's Woodland Campus, <http://hookepark.aaschool.ac.uk/about/>, accessed on July 2019.*

3 *Brian MacKay-Lyons Local Architecture, 99.*

4 *ibid, 13.*

Course Outline:

The course explores the relationships between forests, wood, and craft, and is centred on the Sudden Regional Forest, a mixed forest seven kilometres from the school, with natural stands of oak, hickory and maple as well as plantations of red pine and spruce. The forest is the site of explorations, lectures, and design-build work giving students a theoretical and hands-on knowledge of the wood and its sources. The course will trace the life cycle of trees and wood from their origin in the forest to their final uses in architecture and design, exposing students to general knowledge of forest ecosystems, tree species, forest management, the harvesting, milling and seasoning of wood, and the use of this wood for the fabrication of on-site projects. Over 12-weeks students will engage with the site through drawing, photography, while harvesting and seasoning materials, and participating in the design and fabrication of temporary installations within the site. The course will leverage the expertise of the local wood industry, including forestry professionals, mill workers, loggers, retailers, and craftsmen, who will act as mentors and guests to the program.

Course Objectives:

Through the course, students will gain a nuanced and tactile understanding of timber life cycles including the growth and management of forests, harvesting and milling of trees for wood products, and the transformation of this wood into objects of art and architecture through hand and machine craft. The course will work towards both a theoretical and tactile understanding of the material as well as understanding of terminology associated with timber. Students will be exposed to the environmental and cultural debates surrounding timber use in architecture, and the role of stewardship in maintaining sustainable forests and ecosystems.

Projects:

1) 10 Square Metres of Forest

In groups of 3-4, find a tree or group of trees in the forest. Mark a study are of 10 square metres boundary around the tree using string and sticks. Through drawings, photography, and diagrams, produce a monograph of the site. Study the atmospheric characteristics of the site including light qualities, climate, sounds and textures. Study the types and number of plant life and trees on the site, and their proximity to each other. Document any fungi or traces of animal and insect life of the site. Through research, identify the type of forest which the site is part of, its general characteristics and natural range of the predominant species. Propose some possible ecological relationship between the various species of flora and fauna, and how might or might not contribute to a robust and resilient forest ecosystem.

2) Making Wood

Under the guidance of a registered forest professional and loggers, students participate in the selection and harvesting of a number of trees from the site for use in future projects. After harvest, groups of students will each be assigned a tree, which the are responsible for bucking, milling down using a rented sawmill, and preparing the wood for seasoning by painting edges and stickering on site.

3) A Wood Monologue

In groups of 5-6 propose a temporary installation for the site which uses the wood harvest and any discarded material such as leaves, bark, or limbs. The project should draw awareness to some aspect of forest ecology and use, including issues of human intervention, deforestation and urbanization, or experiential qualities of the site such as light qualities, forests sounds, or daily, seasonal, or long term transformations on the site.

Course Evaluation:

Students will be evaluated on their comprehension and application of course topics. This includes a general knowledge of:

- major tree species in Ontario and the Carolinian forest
- basic tree biology
- forest management practices and types of harvesting
- physical characteristics of wood, including cellular structure, grain, defects
- application of specific wood species in architecture and design
- historic and current wood traditions of various groups in the Ontario region including indigenous use, European settlers including the French, British, and Old Order Mennonite, as well as contemporary uses in architecture and design.

12-Week Course Schedule

Class 1

Forests Ecosystems
Site visit to a local forest accompanied by a naturalist. Guided interpretative walk which exposes students to the biodiversity within Cambridge and forest ecosystem theory and practice.

Class 2

Carolinian Tree Species
An introduction to the tree species in Cambridge with a focus on species used in design and construction.

Class 3

Forest Management - Fires, Insects and Disease
An introduction to forest management practices by a registered professoinal forester including the affect of human forces on tree life through the spread of diseases and the mitigation of fire.

Class 4

Harvest and Seasoning
Full day excursion to a local forest undergoing harvest. Discussion with loggers on site and demonstration of methods of logging from tree to log.

Class 5

Milling & Wood
Tutorial and working time in the UWSA workshop. Exposure for students to basic tools, methods of working, safety, followed by half day of working time.
Site visit to local sawmill.

Class 6

Wood
Discussion on wood economies, in particular Ontario, softwood lumber, social and environmental impacts of logging.
Site visit to A&M Woods: On site lecture from founder of expert on wood qualities, discussion of wood characteristics such as grain, dimensions, colouring, defects, types and qualities of the material.

Class 7 **Wood Traditions**

Lecture on indigenous wood use in Ontario, including methods of cultivation, harvest, and crafting buildings, and objects.

Class 8 **Build Day 1**

Build time in the workshop.

Class 9 **Build Day 2**

Build time in the workshop.

Class 10 **Build Day 3**

Build time in the workshop.

Class 11 **Stewardship & Ethics**

Lecture on the role of architects in the stewardship of forests, trees and materials.

Class 12 **Final on-site reviews - Sudden Regional Forest, Cambridge, Ontario.**

Final Reviews

Studying just one material and its life cycle had the unexpected effect of reminding me of what drew me as a young person looking towards a future profession in architecture. It reminded me that we are responsible for our built environments, and that the environments we create in return have very real impacts on our lives and the lives of others by affecting our well-being, our habits and our experiences in the world. For me, this sense of responsibility now extends towards the materials we use for our buildings, and the ways in which the cultivation and extraction of these materials might impact natural systems at all scales from local to global. The study of trees and wood in the Cambridge region has given me a much deeper feeling for the place in which I live. Walking, observing and learning in the forests of Cambridge broadened my sense of fascination and respect for the vast and intricate natural environments which we depend upon. Giving other students and architects a the opportunity to build up there own experiences and feelings about the place in which they practice seems worthwhile.

Living and practicing architecture in Ontario, Canada, we are ideally suited to be at the forefront of timber use in design and construction and to benefit from its architectural properties and potential contribution towards reducing global warming. For some of us, the experience of timber might remain abstract, in the form of sample books, 2d drawings or specifications in the office. However if more robust interactions with forest landscapes and materials can be embedded into the curriculum of architecture and design students, we open up the possibility to cultivate a more nuanced and knowledgeable use of wood in future generations. The mass adoption of digital technologies which radically change the ways we make and generate form might be tempered by a sensitivity to the subtle physical characteristics of the material learned through hands-on work in forests and workshops. The monotony of our built environments might be interrupted by deeply tactile and inviting buildings and spaces which draw us back to our fundamental architectural experiences and memories of forests, hearths and homes.

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