

# proposal

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## 1 Intro to wood structure and formation

**basic wood structure of hardwoods, briefly touch on differences with softwoods** New edit **basic cell devision** Dicotyledons and gymnosperms grow in two main ways, upward apical growth and outward cambial growth. Note monocotyledons (for example palms) do not produce secondary growth and instead diameter forms as part of primary growth.

As the cambium is forming fusiform and ray initials are created. Fusiform initials are short radially and tangentially with tapered ends. From the cambial initials cells to the inside create the vertical elements of xylem (tracheids, vessels, fibers, parenchyma, etc.), while cells outside become phloem. Ray initials produce horizontal elements (rays).

Cambial cells divide in two ways, periclinal and anticlinal. Periclinal cell division occurs to the inner and outer of the cambial layers. As the cell division to the inside occurs the volume of secondary xylem that is being formed increases the tangential stress on vascular cambium resulting in an extension of the cambial circumference. Although over time many plants show an increase in the longitudinal and tangential dimensions of the cambial initials it is likely that this expansion is mainly facilitated by anticlinal division followed by the expansion of the daughter cells next to the parent.

**cell formation**

**cell elongation/shape change**

**cell death ; final cell shape change and chemical constituents**

**cells/wood in context of wood and whole tree**

## 2 intro to what growth stresses are

ref to above for cell elongation and death

early work in 20s and related models/theories

lignin swelling

cellulose contraction

hemicellulose theories

yamamoto's recent model

issues with current understanding

### **3 why growth stresses exist**

hardwoods v softwoods  
speculation from various authors  
mechanical hypotheses

### **4 intro to the issues growth stresses cause**

for harvesting  
within mills

### **5 background of breeding**

field techniques  
laboratory techniques  
stat techniques  
mention tradeoff with durability etc

#### **5.0.1 breeding work in this thesis**

What we actually have:

Harewood trial: dec 2014 has Bosistoana copied from old planting that mon has GS data from. New Harewood trial, 2016 harvest, will have a number of species potential to copy bos again if needed.

Woodville, 2016/2017 harvest will have Bosistoana, argophloia and possibly globoidea. May or may not be the same families as the various drylands trials.

NOTE family means same mother, not same father. If collected at different times even from the same tree variability exists due to possibility of different set of fathers. Also some selfpropagate, but we don't know which ones or what proportion, so ignore this.

Progeny trials are alpha latitudes, harewood is a standard randomised individual trial.

Contact Ruth McConnochie: rgcmccconnochie@xtra.co.nz for DFI details.

slit tests

surface tests

Potentially use NIR

statistics

### **6 background of chem work**

probably need to talk to clemens about his ideas on testing lignin swelling

- how could we test cellulose contraction? – been done to some extent, maybe copy there method using cells of various stages of development
- what has been done in the past?
- something with NIR, MRI, PET or some other imaging scanning

### 6.0.2 chem in this thesis

Do all of the DFI species have a G-layer? Maybe include some Nitens tests if they do. check MFA and SD for S.2 in tension, normal and compression/opsite wood Get cellulose lignin and hemicellulose(s) contents for tension normal and compression/opsite wood Split hemicelluloses where possible, eg xyloglucan etc. Torsion tests on individual cells, again for tension, normal and compression. Maybe remove G-Layer in tension wood and compare to normal and compression wood of similar MFA and compounds etc.

Could we somehow measure growth stress release on a single cell? Ideally, grow disordered cells invitro, and separate them from the parent cell as soon as possible, then record when in their formation they undergo what dimension changes. Is there some non-destructive test to check what is going on in the cell? or if we have multiple cells in the same conditions maybe we can destructively test some during the growth phase, under the assumption they are all growing at the same time. OR remove the cambial layer leaving top and bottom of cell attached to the stem on a large sample, then somehow remove the connection to the cells behind it, then release the top and measure the contraction.

## 7 background of modeling

yamamoto's most recent attempt

- possible different methods i.e. FEM, DEM, molecular dynamics, geometry of stem and cells

### 7.0.3 modeling in this thesis

cells as particles in relaxed state

- apply body force, i.e. the growth stress field

- get original/non cut stick back

- take groups of representative cells and use composite theory and position dependent body force (growth strain field) from the subdomain above

- introduce time dependence to find out how the stress field develops during maturation, composite scale still

- take individual cells at macromolecular level and try to produce stress field above during a time dependent maturation function

Molecular dynamics simulations to work out the molecular mechanisms developing the growth stresses

- Using the MD sims parameterize a cell model

- Using the cell model develop a time dependent field function

- from the field function create representative cell blocks

put the cell blocks together into a stick  
cut the stick & do we get out what we put it?

## 8 intensions

to improve breeding stock for NZ dryland forestry with respect to eucs being used for structural timber

to increase understanding of growth stress formation particularly in eucalypts by chemical analysis and computer modeling

## 9 objectives

to create a mathematical model and computer simulation of a piece of cambium forming growth

stresses at the macromolecular level

to investigate the chemical causes of GSs by chemical analysis & how?

to improve breeding stock for eucs wrt growth stresses from field and lab testing to select appropriate families.