

# proposal

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## 1 Intro to wood structure and formation

**basic wood structure of hardwoods, briefly touch on differences with softwoods**

**basic cell devision** Dicotyledons and gynosperms grow in to main ways, upward apical growth and outward cambial growth.

Note monocotyledons (for example palms) do not produce secondary growth and instead diamiter forms as part of primary growth.

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

Cambial cells devide in two ways, periclinal and anticlinal. Periclinal cell devision occurs to the inner and outer of the cambil layers. As the cell devision to the inside occurs the volume of seconday xylem that is being formed increases the tangential stress on vascular cambiam resulting in an extention of the cambial cercomfrence. Although over time many plants show an increase in the longitudinal and tangential dimentions of the cambial initials it is likely that this expantion is mainly ficilited by anticlinal devision followed by the expantion of the daughter cells next to the perant.

**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

hemicelluose theories

yamamotos 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 McConnachie: rgcmccnochie@xtra.co.nz for DFI details.

split tests Pairing Test and Longitudinal Growth Strain: Establishing the Association 2008 is the earliest paper I can find on the split/pairing test.

surface tests

Potentially use NIR <http://www.afs-journal.org/articles/forest/pdf/2002/05/05.pdf>

Has some useful info on wave lengths associated with bonds in cellulose

Non-destructive evaluation of surface longitudinal growth strain on Sugi (Cryptomeria japonica) green logs using near-infrared spectroscopy 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 verious stages of development  
what has been done in the past?  
somthing with NIR, MRI, PET or some other imaging scaning

### 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 tesion, normal and compression/opersite wood Get cellulose lignin and hemicellulose(s) contests for testion normal and compression/opersite wood Split hemicelluloses where posable, eg xyloglucan etc. Tortion tests on individual cells, again for tesion, normal and compression. Maybe remove G-Layer in tesion 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 seperate them from the perant cell as soon as posable, then record when in their formation they undergo what dimention 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 destructivly test some during the growth phase, under the assumption they are all growing at the same time. OR remove the cambrail layer leaving top and bottom of cell attached to the stem on a large sameple, then somehow remove the connection to the cells behind it, then release the top and measure the contraction.

## 7 background of modeling

yammamotos most resent attempt  
posable different methods j, FEM, DEM, molecular dynamics, gemometry  
of stem and cells

### 7.0.3 modeling in this thesis

cells as particals in relaxed state  
apply body force, ie the growth stress feild  
get origonal/non cut stick back  
take take groups of represtive cells and use composite theory and position dependnet body force (growth strain feild) from teh subdomain above  
introduce time depedence to fues at how the stress field develops during maturation, composite scale still  
take individual calls at macromolecular level and try to prodiuce stress field above during a time dependent maturation function  
Molecular dynamics simulations to work out the molecular mechanisums developing the growth stresses

- Using the MD sims paramertorize a cell model
- Using the cell model develop a time dependent field function
- from the feild function create representative cell blocks
- put the cell blocks togeather 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 particually in eucallypts by chemical analysis and computer modeling

## 9 objectives

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

- stresses at the macromollecular level

- to investigate the chemical causes of GSs by chemical annalysis ¿¿ how?

- to improve breeding stock for eucs wrt growth stresses from feild and lab testing to select aproprate famielies.