A Summary of Assignment One

Research and Development in Forestry and Wood Sciences

Presented: February 2, 2017
WOOD 465

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Forest Operations

- Tethered falling machines are rapidly being introduced to BC and are currently being investigated in terms of safety, efficiency, and their site disturbance.
- There are different types of tethered falling methods, static/live systems, and tracked/wheeled machines.
- FPInnovations is currently investigating steep slope machines with their Steep Slope Initiative, although there is still much progress to be made.
- Kevin Lyons from the UBC Faculty of Forestry has done research on a different road construction method incorporating mulch gathered from the road right of way.
- Lyon's research shows the benefits in the new method with increased road durability, lower cost/maintenance, and easier deactivation.

Table 2, Field trial results

	Road 1			Road 2			Road 3		
Section	40 RW	20 RW	Soil	40 RW	20 RW	Soil	40 RW	20 RW	Soil
density of mulch (kg/m^3)	285	244	NA	288	251	NA	228	285	NA
volume of mulch (m^3)	68.09	41.26	NA	89.8	62.01	NA	125.11	72.76	NA
mass of mulch (kg)	19411	10073	NA	25834	15550	NA	28528	20736	NA
minimum depth of mulch (m)	0.21	0.03	0	0.19	0.02	0	0.21	0.1	0
Passes to failure	70	10	1	112	6	1	86	46	1

Forest Management- Enhanced Forest Inventory (EFI)

- R&D in forest management has been developing enhanced forest inventories (EFI) that provide more detailed and accurate information of forest resources to support efficient and cost-effective use.
- As research provides a better understanding of the fibre characteristics required for certain products to be developed, technologies that can identify fibre characteristics in the forest and separate trees for particular end-uses becomes extremely valuable.
- Remotely sensed imagery is one of leading technologies in supporting EFI's. One example is LiDAR systems (light detection and ranging), which can provide high-accuracy data on vegetation, ground surface, and overall forest cover through measured laser impulses emitted and reflected back to a sensor. Using ground based LiDAR technology to complement aerial systems can provide even finer geometrical and bio-physical details including accurate estimates of volume, basal area, and fibre attributes connected to wood quality.
- Developing EFI's will allow for companies to more effectively harvest and provide the right timber to the right mills, providing value-chain optimization in the forest industry.

Engineered Wood Products

- There are numerous companies focused on research and development relating to engineered wood products including FPInnovations, UBC Timber Engineering and Applied Mechanics Branch, and the Engineered Wood Association.
- There is a large variety of products including plywood, oriented strand board (OSB), glulam, cross-laminated timber (CLT), I-joists, structural composite lumber (SCL), high or medium density overlay (HDO or MDO), radiant barrier panels, etc.
- Constructed by heating and compressing veneer or wood strands and create products that are more consistent and outperform traditional wood products. Also does not require aesthetically pleasing wood.
- Ongoing research is aimed at further increasing utility by using different species, increasing efficiency of product development, developing new construction systems for engineered wood products, and by examining performance in different applications

- Viewed as sustainable source of building material that provides a carbon sink rather than a source. This is encouraging increased demand for engineered wood products.
- More work is needed in order to increase consumer awareness of wood products and to change construction restrictions regarding wood structures.
- More applications are using engineered wood products and for larger projects. This is gradually reducing regulatory restrictions.

Biorefinery and Energy

- R&D into biorefinery and energy aims to replace petroleum products with sustainable wood-derived substitutes while exploring new economic opportunities.
- Lignocellulosic biomass (including cellulose, hemicellulose, and lignin) are the building-blocks for these opportunities and can be converted to ethanol; pretreatments needed to allow conversion by reducing recalcitrance (strength of the crosslinking of wood fibres).
- Improving costly pretreatment techniques, using genetically modified trees with lower recalcitrance, and using "green" chemicals are options being researched. Also being explored is the development of integrated pulp mills that re-use hemicellulose "waste" as biomass for ethanol production.
- Most promising alternatives being researched include consolidated bioprocessing (which uses enzymes from thermophilic anaerobic microbes or more recently fungi enzymes to convert lignocellulosics into ethanol in a single stage via hydrolysis and fermentation, thereby reducing costs).
- Present research is considering ways to more efficiently recover and convert 5C and 6C sugars to ethanol. Controlled catalytic dehydration-hydrogenation reactions (non-biological) is promising as can converts 5C sugars into hydrocarbons, which can be used for transportation fuels.
- The biorefinery of chemical products allows for pure or mixed extracts to be turned into value-added products; over 100 chemicals may be derived from wood or foliage to be used in pharmaceuticals, fragrances, food additives, nutrient supplements, and more.

Nanocellulose

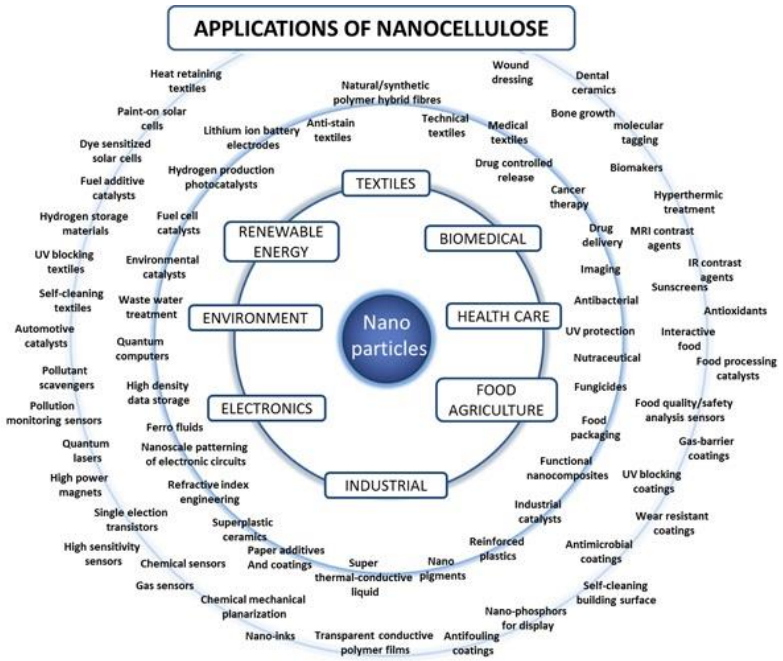

Image adapted from (Simonson, 2011).
Source: http://people.forestry.oregonstate.edu/john-simonsen/research-areas

- Nanocellulose has a wide range of applications both as product enhancers, and novel products.
- Many names but major types: cellulose nanocrystals **(CNC)** and cellulose nanofibrils **(CNF).**
- Lightweight, conductive, non-toxic, transparent, impermeable, high rigidity and tensile strength, absorbent, unique rheology, quantum behavior at nano-scale.
- Commercial production mainly by high energy mechanical disintegration (70,000MWh/t).
- Novel chemical and biological pretreatments in research to drive down the energy cost.
- Sappi company has built a pilot-scale plant in the Netherlands.

References

Bharimalla AK, Deshmukh SP, Patil PG, and Vigneshwaran N. (2015). Energy Efficient Manufacturing of Nanocellulose by Chemo - and Bio - Mechanical Processes: A Review. World J. Nano Sci. Eng. 5:204–212.

Capolupo, L, and Faraco, V. (2016). Green methods of lignocellulose pretreatment for biorefinery development. Applied Microbiology and Biotechnology. 22:9451–9467.

Cherubini, F. (2010). The biorefinery concept: Using biomass instead of oil for producing energy and chemicals Energy Conversion and Management 51: 1412–1421.

Devappa, R.K., Rakshit, S.K., and Dekker, R.F.H. (2015). Forest biorefinery: Potential of poplar phytochemicals as value-added co-products Biotechnology Advances 33: 681–716.

Engineered Wood Association, The. (n.d.). *Engineered wood products for superior performance*. Retrieved 27 Jan. 2017, from https://www.apawood.org/products

Faculty of Forestry Timber Engineering and Applied Mechanics. (n.d.). *Research*. Retrieved 27 Jan. 2017, from http://team.forestry.ubc.ca/research/

FPInnovations. (n.d.). *Forest Operations Modelling & Decision Support*. Retrieved 28 Jan. 2017, from https://fpinnovations.ca/ResearchProgram/forest-operations/modeling-and-decision-support/pages/current-projects-2016-2017.aspx

FPInnovations. (n.d.) "Goals." Steep Slope Initiative. FPInnovations. Retrieved 26 Jan. 2017, from http://steepslopeinitiative.fpinnovations.ca/goals/

FPInnovations. (n.d.). *Research Programs*. Retrieved 27 Jan. 2017, from https://fpinnovations.ca/ResearchProgram/Pages/research-program-overview.aspx

FPInnovations. (n.d.). *Research Programs: Biorefinery and Energy*. Retrieved 25 Jan. 2017, from https://fpinnovations.ca/researchprogram/pages/research-program-biorefinery-energy.aspx

Guo M, Song W, and Buhain, J. (2015). Bioenergy and biofuels: History, status, and perspective. Renewable and Sustainable Energy Reviews. 42:712–725.

Lyons, C. K., Day, K., & Lake, B. C. Extending the logging season in Mountain Pine Beetle damaged stands by using ground wood to surface in-block roads. FSP_M085197

Natural Resources Canada. (2016). *Enhanced forest inventory techniques*. Retrieved 28 Jan. 2017, from http://www.nrcan.gc.ca/forests/measuring-reporting/inventory/13421

Nechyporchuk O, Belgacem MN, Bras J. (2015). Production of cellulose nanofibrils: A review of recent advances. Ind. Crops Prod. 93:2–25.

Pu, Y., Zhang, D., Singh, P.M., and Ragauskas, A.J. (2008). The new forestry biofuels sector. Biofuels, Bioprod. Bioref. 2(1): 58–73.

Simonsen J. (2011). Research Areas Cellulose Nanocrystals. Oregon State University. Retrieved 27 Jan. 2017, from http://people.forestry.oregonstate.edu/john-simonsen/research-areas