A Short Summary of the Taxonomy of Pulp and Paper Products:

Based on A New Taxonomy of Pulp and Paper Products by Marie Dumontier and David Cohen, 2015

Background to Taxonomies

Setting the Stage
- Most of forest land in Canada owned by Provincial governments (not the global norm)
  - exceptions include Irving (mostly NB and Maine) and Vancouver Island in BC
- All firms want to maximize return to log i.e. make products from the log that will generate the highest value products

Canada’s Wood Supply
- Largest (diameter & height) in BC and Alberta - larger closest to coastal BC
- Central & Eastern Canada has shorter, skinnier, more twisted trees
- Faster growing in southern regions
- More hardwood in Ontario & Quebec
- Industry concentrating on lumber in Western Canada
- Industry concentrating on pulp & paper in Central & Atlantic Canada
- Larger sawmills in West; More pulp mills in Central & East
- Higher quality lumber in West
Background on Pulp

**Wood** — made up of cellulose, hemicellulose and lignin. Cellulose is main component & provides strength. Hemicellulose absorbs water necessary for tree growth while lignin is the glue that holds it all together.

**What is pulp** — The pulping process separates cellulosic fibres by removing the glue-like lignin. The more lignin and hemicellulose removed, the higher the pulp quality and the lower the of yield.

**What is pulp made from** — globally about 60% is made from recycled paper and 40% from wood fibres (called virgin pulp)

**Where is it made** — Historically in northern regions from softwoods (SW): SW pulp - US 1/3, & 20% each for Nordic countries & Canada
HW pulp Brazil & US 20% each

**How is it made** — Three processes: Chemical (high quality, low yield), Mechanical (low quality, high yield) and using recycled paper

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**Pulp – The Big Picture (Source: RBC)**

- Market Pulp — 31%
  - 56% Recycled
  - 44% Virgin fibre

- Emerging materials
  - CNC (Cellulose NanoCrystal) — additive in reinforced plastics, composites, paints & coatings, oil & well cementing

- Global Use for Pulp 2014
  - Printing & Writing Papers 26% ↓
  - Newsprint & Packaging 53% ↓
  - Paperboard 12% ↑
  - Tissue 8% ↑
Mechanical & Chemical Wood Pulping

Mechanical
- Grinds wood between large rotating metal discs to make fine particles
- High yield (>85% of wood) but weak and yellows when exposed to light
- Used to make newsprint and some packaging

Chemical
- Uses chemicals to break apart the wood fibres
- Two processes: 1) kraft (aka sulfate process) uses alkaline chemicals; 2) sulfite process uses acidic chemicals
- Kraft in newer, used more often and Sulfite declining

Trends in Pulping

Over past 20 years there have been 3 major trends

1. Environmental Eliminating toxic pollutants, ↓ water use, ↑ energy self-sufficiency, close loop chemical recovery
2. Continuous improvement ↑ pulp quality from same wood source → can be used to produce papers that used to require higher grades of pulp. (tech & process control)
3. Production shift to southern developing countries (Brazil, Chile, Uruguay, Indonesia, China, etc.)

A modern pulp mill is a “biorefinery” that produces pulp, bioenergy and/or specialty materials & products
Globalization & Pulp (past 25 years)

New market demand & production from emerging economies

- Growing demand from China, (BRICs and MIST)
  BRICs (Brazil, Russia, India, China & S. Africa)
  MIST (Mexico, Indonesia, South Korea, Turkey)
- Growing production from China, Brazil, Uruguay, & US South
  with continuous processing improvements ➔ lower cost
  competition for Canadian Pulp
- NOW global market, global supply, global pricing, global
  competition

Highest impact trend (FAO data)

- Reduced demand due
to digital explosion
- Reading newspapers,
  books or flyers online
- Communicating with
text messages on cell
  phones, email or social
  network sites
- Decline continues &
  spreading to developing
  countries

From Bloomberg Business News 12/20/15

NA Demand for Newsprint
Pulp – Key Takeaways

• Producing pulp is now one of the most environmentally efficient global businesses, using renewable material to produce complex products, materials and energy

• Increasing competition from lower cost regions with fast rotations combined with the decline in paper use has led to serious challenges to northern forest sectors

• This leads to new opportunities for wood chips from lumber production ranging from energy to biofuels, from refining chemicals to new materials and textiles led by government supported R&D in Canada and Europe

• Canadian pulp & paper sector now in “creative destructionism” phase of business transformation

Highest impact trend (again)

• Reduced demand for newsprint and printing & writing (graphic) papers due to the digital explosion

• Reading newspapers, books or flyers online

• Communicating - text messages on cell phones, email or social networks

• Decline continues & now spreading to developing countries

Making Paper - a thin, flexible sheet usually made from wood pulp

Communication Papers

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<th>Papers</th>
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<td>Newsprint</td>
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<td>Uses</td>
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<td>Trends in Usage</td>
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Mechanical paper has more than 20% mechanical pulp (aka groundwood paper e.g. UG)
Freesheet is paper made from > 80% chemical pulp and (aka woodfree paper)
Uses Improved processing technology enables lower quality, lower cost pulps to be used to produce higher quality papers (ongoing substitution)
Packaging - wrap and containers to transport materials & goods

Boxboard (Paperboard in US)
Folding cartons e.g. cereal boxes

Corrugated Box (aka Containerboard)
A cardboard box with a wavy cardboard interior sandwiched between 2 smooth pieces of linerboard

Key Points on Packaging
• Growth with GDP in developed countries and higher in developing countries
• Driven by:
  ✓ internet sales
  ✓ shift to “greener” packaging (heavy use of recycled material to produce packaging)
  ✓ easy open packaging for growing seniors population

Corrugated box (aka containerboard or cardboard box)
• Made by gluing a wavy sheet of paperboard (corrugated medium) in between two layers of smooth linerboard
• Used to ship:
  ✓ groups of boxed consumer goods
  ✓ heavy products such as electronics
  ✓ online purchases for delivery
• Almost all boxes made in Canada uses 100% pulp from recycled boxes
• Growth will continue to meet growing online sales and easy open packaging for seniors

Making Board for Packaging

Board for packaging manufacturing process

Microscraped board, paper and water in paper (plant blends)
Series of cleaning processes to remove impurities
Board machine forms wet web of cleaned fibres
Mat is dried and pressed between rolls to form new board
Dried and spooled onto rolls or cut into sheets

Recycled Paper (Speculation)
• Recycling rates, production, trade and use have increased steadily over the past 25 years
• Now provide almost 60% of all pulp used worldwide

• Use of communication papers in steady decline due to internet, cell phones, tablets and all things ONLINE
  ➔ less paper available for recycling

• Shortage of paper for recycling
  ➔ ↑ pressure on prices for recycled material, recycled pulp & virgin pulp
**Hygiene** aka sanitary and household papers

**Key Points on Hygiene Products**

- Wide range of hygienic products used in the home, commercial & industrial places
- Three categories:
  - tissue (made in Canada)
  - towels (made in Canada) &
  - personal care products

- One of the fastest growing segments that use pulp driven by:
  - developing countries reduce poverty & middle class growth in developed countries
  - many P&P firms shifting to this category e.g. Irving & Domtar

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**Existing Materials**

- Broad array of materials produced form pulp, some for many decades: tall oil, turpentine, carboxyl methylated cellulose, xylose, lignin, biomethanol, lignosulfonates
- Some refined pulping produce materials such as lignin or turpentine
- In chemical pulping lignin (in the waste liquor) is burned to produce bioenergy
  - Canadian kraft mills are almost energy self sufficient
- in some NA sulfite mills, xylose (a sugar) has been extracted and used to produce xylitol, a common food sweetener

_Today there is virtually no waste from a pulp mill_

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**Making Hygiene Products**

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**Emerging Materials**

For over a decade government, provinces and industry has developed new processes, products, & markets for new wood materials. Examples bellow

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<th>Process</th>
<th>Example</th>
<th>Markets</th>
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<tr>
<td>Recovery of pure lignin</td>
<td>LignoForce™ commercial lignin recovery plant (West Fraser BC)</td>
<td>a renewable, natural replacement for certain glue components in EWP</td>
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<tr>
<td>Recovery of hemicellulose</td>
<td>Extract hemicellulose from wood chips without chemicals (Cascades, Quebec)</td>
<td>reduce energy consumption, waste, and pollution to provide greener material</td>
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<tr>
<td>Nano Crystalline Cellulose (NCC)</td>
<td>CelluForce, JV of Domtar &amp; FPI for pilot plant in Quebec</td>
<td>produce a high-value nanomaterial that can be used for a wide variety of products</td>
</tr>
<tr>
<td>Cellulose Filaments (CF)</td>
<td>Peels filaments from wood fibres</td>
<td>as reinforcement additive to paper, plastics, &amp; adhesives.</td>
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