Taxonomy of Pulp and Paper Products:
What is it, Production, Uses, and Trends

Based on A New Taxonomy of Pulp and Paper Products by Marie Dumontier and David Cohen, 2015
prepared for the CFS web site

Pulp - a fibrous material made from the components of wood made into a mat
- Paper - a thin, flexible sheet made from wood pulp
- Packaging - is made from paper or paperboard (paper that is thicker and stronger) to wrap or contain materials and goods for transport
- Hygiene Products – (aka sanitary & household papers) are a wide range of hygienic products used in the home as well as commercial and industrial premises
- Other Materials - Some pulping processes have been refined to extract and purify other materials such as lignin or turpentine. Other processes use wood components to produce bioenergy.
Background on Pulp

**Wood** — made up of cellulose, hemicellulose and lignin. Cellulose is the 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 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) but increasing from hardwoods (HW) from equatorial regions:
- Today 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
Pulp – The Big Picture

- 433 million tons
  - 56% Recycled
  - 44% Virgin fibre
  - Mechanical, integrate & non-wood pulp – 69%
  - Market Pulp – 31%

Paper Production

- 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 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
- 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

Increasing discount list prices for pulp in soft markets e.g. 2003-13
list price ↑ $US 150/tonne but discounts ↑ from 8% to 22%
Beware too much reliance on list prices

Highest impact trend

- Reduced demand for newsprint and P & W (graphic) papers 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

**Graphic Paper** - all grades of paper used for printing, writing or reading (e.g. newsprint and office papers)
NBSK (Northern Bleached Softwood Kraft)

- **Canada produces almost one-third of world’s NBSK production & has almost 75% of NA NBSK capacity**
- 80% of Canadian production is sold as market pulp mostly to US & Chinese producers of various paper, packaging and hygiene products
- Demand is shrinking for traditional uses (newsprint and other communication papers) with increased use in tissue & towels easing some of the pain
- **Total Canadian production decreased 21% from 2003-2013**
  decline continues as R&D explores new uses for NBSK
Dissolving Pulp

**Two types: Commodity and Specialty**

**Commodity Dissolving Pulp**
- is a special type of refined kraft or sulfite wood pulp used to produce rayon for the textile industry
- competes with cotton & rayon from oil and bamboo
- demand is growing but global supply has been growing faster

**Specialty Dissolving Pulp**
- is a highly-refined sulfite pulp with a very high cellulose content & very low level of impurities
- used to produce chemicals such as acetates and ethers used as texturizers in ice cream, adhesive, explosives, etc.
- very few firms in very few countries produce this

Competing pulps produced elsewhere

**Fluff pulp**
- is a chemical pulp produced from long fibre softwood and hardwoods with thick walls for superior absorbency & bulk
- ideal to make diapers, tampons and bandages
- SYP has ideal species but BEK starting to compete

**Bleached Eucalyptus Kraft (BEK) Pulp**
- is a type of bleached hardwood kraft pulp made from eucalyptus trees grown in plantations in southern regions with short rotation ages (e.g. 7 years)
- used for printing and writing papers and tissues
- low cost & increasing global production → ↑ competition
Pulp – the short story

- Producing pulp has become one of the most environmentally efficient global businesses worldwide, 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.

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

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Paper a thin, flexible sheet made from wood pulp

**Communication**

- Newsprint
- Uncoated mechanical
- Coated mechanical
- Uncoated freesheet (UFS)
- Coated freesheet (CFS) for magazines, etc.

**Specialty papers** for food packaging, pharmaceutical inserts, etc.

**Unbleached Kraft paper**

Used for paper bags

**Key Points Communication Papers**

- Communication papers are listed in terms of quality & durability with newsprint being the lowest.

- Communications paper (newsprint) was Canada’s main paper product.

- Reduced demand for newsprint and printing and writing (P&W) papers due to the digital explosion.

- In the past specific pulps produced certain types of paper, no longer.
Making Paper

Paper making process:
- Mix pulp with water to make a slurry
- Spray slurry over mesh to make a mat then drain
- Pressure compresses the mat and removes remaining moisture
- Dry the mat
- Optional:
  1) Coat 1 or 2 sides of the paper and then iron the paper to smooth the surface (calendering) or
  2) Calendar or supercalender the paper
- Wrap paper on large roll or cut to size to ship

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
Communication Papers

<table>
<thead>
<tr>
<th>strength and quality</th>
<th>LOW</th>
<th>Newsprint</th>
<th>Uncoated Mechanical</th>
<th>Coated Mechanical</th>
<th>Uncoated Freesheet</th>
<th>Coated Freesheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses</td>
<td>used for bulk newspapers short term use &amp; low strength</td>
<td>used for higher quality coloured printing in newspapers</td>
<td>used for magazines and glossy newspaper inserts</td>
<td>used for office paper for printing and copying</td>
<td>used for high quality magazines, brochures, and books</td>
<td></td>
</tr>
<tr>
<td>Trends in Usage</td>
<td>rapidly declining</td>
<td>changing uses</td>
<td>declining use</td>
<td>declining use</td>
<td>declining use</td>
<td></td>
</tr>
</tbody>
</table>

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)

Specialty Papers
- Specially designed papers grouped together since each one is produced for very particular applications that serve a niche market
- Examples: opaque printing papers for bibles, financial printing etc., food wraps, baking paper, dental tray coverings, sandpaper, etc.

Unbleached Kraft Paper
- A high-strength paper made from unbleached kraft pulp used to make paper bags for consumer and industrial use that is air permeable (e.g. compost and yard waste bags)
- Most used to ship industrial products e.g. agricultural, chemicals

Smart Paper
- A really cool emerging area of specialty papers often with embedded computerized or biological sensor e.g. bioactive papers, RFID,
**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
- Higher growth in developing countries (the China factor)
- Driven by:
  - internet sales
  - shift to “greener” packaging (heavy use of recycled material to produce packaging)
  - easy open packaging for growing seniors population

**Making Board for Packaging**

- **Mix recycled board, paper and water in pulper (giant blender)**
- **Series of cleaning processes to remove impurities**
- **Board machine forms wet web of cleaned fibres**
- **Mat is drained and pressed between rolls to form new board**
- **Dried and spooled onto rolls or cut into sheets**
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
- Most boxes made in Canada uses 100% pulp from recycled boxes
- Growth will continue to meet growing online sales and easy open packaging for seniors

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

- **Tissues** facial & toilet paper
- **Towels** paper towels – strength & absorbency
- **Personal care** diapers & sanitary napkins

**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 & grow middle class (China factor)
  - growth of elderly in developed countries
- many P&P firms shifting to this category e.g. Irving & Domtar

**Making Hygiene Products**

- Mix recycled paper with virgin pulp (NDEP, NMP, K C, TMP) with water (optional is resin for wet strength) to make slurry
- Spread slurry on paper machine to form web
- Remove water by draining and pressing
- Dry out by rolling it around large steam heated cylinder
- Wrap dry sheets onto large rolls (called parent rolls)
- Converted on site or parent rolls sent to plants to manufacture final product
Tissue
- a lightweight, soft and absorbent product used as bathroom tissue, facial tissue, and napkins
- Key properties are absorbency, stretch, appearance, softness and strength (especially when wet)
- Made from kraft and recycled pulp (BEK lowest cost kraft alternative)
- Canada export > 90% of their tissue to the US for final manufacture

Towel
- an absorbent disposable product used primarily for drying hands and cleaning hard surfaces such as windows
- Key properties are durability, absorbency and strength when wet
- Made from pulp mixed with resin to improve wet strength
- Canadians export > 90% of their tissue to the US for final manufacture
- Emerging trend towards higher quality towels
Existing Materials

- Broad array of materials produced from pulp, some for many decades: tall oil, turpentine, carboxyl methylated cellulose, xylose, lignin, biomethanol, lignosulfonates
- Some pulping processes have been refined to extract and purify other 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
- Ash composed of chemicals that are reused in the pulping process

Existing Materials

- In some NA sulfite mills, xylose (a sugar) has been extracted and used to produce xylitol, a common food sweetener used in chewing gum and baked goods
- Biomethanol, used in windshield washer fluids, can also be derived from hemicellulose as a by-product of the kraft pulping process
- Cellulose is used as food additive to increase fibre: your sandwich may include wood fibre
- Today there is virtually no waste from a pulp mill
Emerging Materials

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

<table>
<thead>
<tr>
<th>Process</th>
<th>Example</th>
<th>Markets</th>
</tr>
</thead>
<tbody>
<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>
</tr>
<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>
</tr>
<tr>
<td>Nano Crystalline Cellulose</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 (pilot plant Kruger, Quebec)</td>
<td>as reinforcement additive to paper, plastics, &amp; adhesives.</td>
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</tbody>
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Pulp

Kraft
- NBK (Northern bleached softwood kraft)
- NBHK (Northern bleached hardwood kraft)
- Sulfite
- Commodity Dissolving
  - Speciality Dissolving
  - BEX (Bleached Eucalyptus kraft)
- Fluff Pulp

Chemical Pulp
- TMP
- BCTMP aka High Yield Pulp (HYP)

Mechanical Pulp
- Recycled / Damned

Legend
- Chemical Pulp
- Mechanical Pulp
- Made in Canada
- Not made in Canada

Paper
- Communication
  - Newspaper
  - Uncoated mechanical
    - Uncoated free sheet (US)
    - Coated free sheet (CFS) for magazines, etc.

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

Hygiene
- Tissues facial & toilet paper
- Towels paper towels – strength & absorbency
- Personal care
  - diapers & sanitary napkins

Emerging materials
- CNC (Cellulose NanoCrystalline) additive to reinforce plastics, resins, coatings, paint & packaging, oil well-screwing (pilot plant in Canada in 2012)
- CF (Cellulose Filaments) a strengthening biomaterial with many potential uses (pilot plant in Canada in 2014)

Existing materials
- Lignin
- Biomethanol
- Tall Oil
- Turpentine
- Bioenergy
- Xylose
- Carbon-methylated Cellulose
- Lignosulfonates

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