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**SUSTAINABILITY-DRIVEN INNOVATION IN THE PULP  
AND PAPER INDUSTRY**

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*ABSTRACT*

The timber, pulp, and paper industries (collectively referred to as “the Industry”) have constantly faced environmental challenges, given how resource-intensive their operations are. Pulping and bleaching processes not only use waste amounts of timber and water but often include materials capable of polluting local air quality and waterways.<sup>1</sup> Though critics view the Industry’s business model as inherently harmful to the environment, the Industry is focused on sustainability, given the need to preserve the resources on which the Industry depends to create its products.

This Article considers whether the Industry can produce high-quality, affordable, and environmentally friendly products on a large enough scale to be profitable. Additionally, this Article examines whether the Industry can be innovative in a sustainable manner when confronted by disruptive situations. For example, the ongoing coronavirus disease pandemic (“COVID”) represents the type of challenges facing the Industry going forward. COVID disrupted global supply chains, production lines, and consumption patterns while the demand for paper products remained extremely high, requiring the Industry to operate at unforeseen production levels.<sup>2</sup>

More specifically, the Article discusses the requirements for each sector of the Industry to remain viable when confronted by both short-term and long-term sustainability challenges. Companies need to determine whether to prioritize long-term investment in new processes and product innovation rather than jettisoning those investments for short-term returns expected by the broader shareholder base. An industry that successfully addresses these disruptions should have an awareness of its short and long-term drivers in sectors like resource, product, and waste management to maximize innovation.

Part I contains an overview of the Industry and relevant products of the three major segments. Part II the production process and how the Industry is able to recapture many of its byproducts in and reuse them in a circular manner. Part II describes the general notion of sustainability, sustainability-oriented innovation, and resource management. It also considers the specific ways in which each sector of the timber, pulp, and paper industry must innovate in order to achieve

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<sup>1</sup> NAT’L. RSCH. COUNCIL, SEPARATION OF TECHNOLOGIES FOR THE INDUSTRIES OF THE FUTURE 83 (1998).

<sup>2</sup> See Ignacio Felix et al., *US Food Supply Chain: Disruptions and Implications from COVID-19*, MCKINSEY & COMPANY 3 (July 2, 2020), <https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/us-food-supply-chain-disruptions-and-implications-from-covid-19>.

sustainability. Part III surveys the challenges facing each segment, and Part V studies the reasons for stagnant innovation in the Industry.

## I. INTRODUCTION TO THE INDUSTRY

The Industry can be divided into three major segments: timber, pulp, and paper.<sup>3</sup> Each segment represents a different aspect of the production lifecycle. Timber companies focus on managing the raw material, cultivating timber, lumber, and real estate assets.<sup>4</sup> Pulp mills specialize in the Kraft process and convert recycled materials and wood chips into pulp fibers that can be shipped to a manufacturing facility for production of paper or textiles.<sup>5</sup> Finally, paper companies make the end product, in partnership with timber and pulp experts.<sup>6</sup> Each sector plays an important role in the Industry's claim of circularity. Although often referred to collectively as the pulp and paper industry, each segment of the Industry operates both separately and collaboratively.

### A. Timber

Timber represents a business structure that is different than its more production-heavy counterparts. Generally taking the form of a Real Estate Investment Trust ("REIT"), a company in this sector owns and manages the timberland real estate that is the backbone of the Industry.<sup>7</sup> The forest products industry has enthusiastically embraced REITs.<sup>8</sup> In the 1970s, Goldman Sachs issued a report that suggested that most of the largest public forest products and paper companies were trading below the value of their timberland holdings, including large companies like Weyerhaeuser.<sup>9</sup> Within a few decades, Timber REITs began to explode, particularly when Plum Creek Timber Co. converted from a limited partnership to a REIT.<sup>10</sup> Other companies soon followed suit, given findings that investors preferred timberland assets held in the

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<sup>3</sup> See *Pulp, Paper and Wood Products Industries*, FOOD AND AGRIC. ORG. OF THE UNITED NATIONS, <http://www.fao.org/forestry/industries/en/> (last updated Nov. 25, 2020).

<sup>4</sup> Cf. *Forest, Paper & Packaging*, PWC, <https://www.pwc.com/gx/en/industries/forest-paper-packaging.html> (last visited Dec. 5, 2020).

<sup>5</sup> See *id.*

<sup>6</sup> *Id.*

<sup>7</sup> Michele Lerner, *Timberland REITs Standing Tall*, NAREIT (July 20, 2015), <https://www.reit.com/timberland-reits-standing-tall>.

<sup>8</sup> Brooks Mendell, *From Cigar Tax to Timberland Trusts*, 2016 FOREST HISTORY TODAY 32, 33 (2016).

<sup>9</sup> *Id.*

<sup>10</sup> *Id.* at 34.

more limited REIT corporate structure than in any other corporate structure.<sup>11</sup>

In 2009, Weyerhaeuser, one of the world's largest and oldest diversified forest products companies, announced its board had approved REIT conversion.<sup>12</sup> Then in February 2016, Weyerhaeuser and Plum Creek, the two largest timber REITs in the world, combined to become a REIT behemoth, a timber REIT with more than 13 million acres of the most productive and diverse timberland in the U.S.<sup>13</sup> The combined timber REIT is the second largest landholder in the USA after the Federal Government.<sup>14</sup> Valued at \$8.3 billion, the merger made Weyerhaeuser the largest private landowner in the United States.<sup>15</sup>

Weyerhaeuser had historically been an expert in forestry management. Weyerhaeuser Timber Company was founded in 1900 as a forest products company, purchasing 900,000 acres of Washington state timberland from the Northern Pacific Railroad.<sup>16</sup> Weyerhaeuser eventually began to meet a variety of national timber needs, including providing spruce wood to build World War I airplanes, ships, and army barracks.<sup>17</sup> At one point, the Army dispatched soldiers to Weyerhaeuser land holdings to help harvest lumber for the war effort.<sup>18</sup> In 1925, Weyerhaeuser created a new subsidiary, the Weyerhaeuser Logged-Off Land Company, which was in part designed to study and encourage the long-term health of forest holdings through tactics like reforestation.<sup>19</sup> Its CEO was an early proponent of sustainable forestry, lobbying the federal government for lower taxes in exchange for reforestation efforts and cooperative forest fire prevention.<sup>20</sup> Their lobbying led to the expansion of the National Forest System and federal assistance to states for forest fire prevention and distribution of tree seedlings.<sup>21</sup>

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<sup>11</sup> *Id.*

<sup>12</sup> *Weyerhaeuser Announces Intent to Elect REIT Status: Timing Under Consideration*, WEYERHAEUSER (Dec. 15, 2009), <http://investor.weyerhaeuser.com/2009-12-15-Weyerhaeuser-Announces-Intent-to-Elect-REIT-Status-Timing-Under-Consideration>.

<sup>13</sup> Sandra Ward, *Sizing Up the Weyerhaeuser Plum Creek Merger*, BARRON'S (Nov. 14, 2015) <https://www.barrons.com/articles/sizing-up-the-weyerhaeuser-plum-creek-merger-1447477645>.

<sup>14</sup> *Id.*

<sup>15</sup> *Id.*

<sup>16</sup> *History*, WEYERHAEUSER, <https://www.weyerhaeuser.com/company/history/#0> (last visited Dec. 5, 2020).

<sup>17</sup> *Id.*

<sup>18</sup> *Id.*

<sup>19</sup> *Weyerhaeuser Company*, ENCYCLOPEDIA.COM, <https://www.encyclopedia.com/social-sciences-and-law/economics-business-and-labor/businesses-and-occupations/weyerhaeuser-company> (last visited Dec. 5, 2020).

<sup>20</sup> *Id.*

<sup>21</sup> *Id.*

Therefore, it seems only natural that Weyerhaeuser turned away from the pulp and paper aspect of the Industry to focus on its timberland holdings. The company's most valuable assets were its two million acres of forest in the Pacific Northwest.<sup>22</sup> In 2007, Weyerhaeuser completely exited its commercial paper business and spun off its subsidiaries to Domtar, Inc., a Canadian pulp and paper company.<sup>23</sup> In 2007, Weyerhaeuser sold its containerboard, packaging, and recycling assets to the International Paper Company for \$6 billion in cash.<sup>24</sup> On April 16, 2010, Weyerhaeuser shareholders officially voted for a REIT conversion.<sup>25</sup> The merger with Plum Creek in 2016 only made the conversion more lucrative.<sup>26</sup> Weyerhaeuser was focused on sustainable forestry practices, while Plum Creek specialized in optimizing land values.<sup>27</sup> Weyerhaeuser and Plum Creek had different areas of expertise but both entities were focused on resource management for the Industry.<sup>28</sup> The combination was a compelling way of sharing expertise.<sup>29</sup>

Critics are still divided on the overall market significance of the Weyerhaeuser and Plum Creek merger. Some analysts argued that the merger, which created the country's largest private landowner, could be well-positioned for strong long-term growth, particularly as the housing market improved.<sup>30</sup> Others argue, however, that the merger emphasizes

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<sup>22</sup> Joan E. Solsman, *Weyerhaeuser to Convert to REIT*, WALL STREET JOURNAL, <https://www.wsj.com/articles/SB10001424052748704398304574597771927562160> (Dec. 15, 2009).

<sup>23</sup> *Weyerhaeuser, Domtar Ink Fine Paper Deal*, NBC NEWS (Aug. 23, 2006, 7:27 AM), <https://www.nbcnews.com/id/wbna14471078>. It was this spinoff that led to speculation in the market that Weyerhaeuser was considering conversion to a REIT, which Weyerhaeuser initially denied. The company was required to show the IRS that it was converting to a REIT for "legitimate business reasons" and not simply for tax avoidance purposes. At the time of the Domtar spinoff, Weyerhaeuser had too many non-real estate assets to qualify for REIT status, and the company did not want to tip off the IRS of its intentions to convert. When Weyerhaeuser denied rumors of a REIT conversion, its stock price fell 7.6%, a five-year low, since it then appeared to the market that Weyerhaeuser was slashing capital spending and spinning off profitable divisions with no real endgame.

<sup>24</sup> *Weyerhaeuser Sells Packaging Unit for \$6B*, NBC NEWS (Mar. 17, 2008), <https://www.nbcnews.com/id/wbna23673775>.

<sup>25</sup> *Weyerhaeuser Shareholders' Vote Clears Path for REIT Conversion*, WEYERHAEUSER (Apr. 16, 2010) <http://investor.weyerhaeuser.com/2010-04-16-Weyerhaeuser-shareholders-vote-clears-path-for-REIT-conversion>.

<sup>26</sup> Ward, *supra* note 13.

<sup>27</sup> *Id.*

<sup>28</sup> *Id.*

<sup>29</sup> *Id.*

<sup>30</sup> *Weyerhaeuser and Plum Creek to Merge, Creating the World's Premier Timber, Land, and Forest Products Company*, WEYERHAEUSER (Nov. 8, 2015),

the relative insignificance of timber REITS, which account for only three percent of the REIT sector overall.<sup>31</sup> Additionally, Weyerhaeuser, though now the largest private landowner in the United States, still accounts for only a fraction of private timberland and real estate assets, dwarfed by millions of small and mid-sized private landowners.<sup>32</sup> Finally, and most importantly to the long-term viability of REITs, the merger questions what growth and profit options remain for REITs. Timberland is a limited resource and particularly in a market in which timber REITs buy and sell to and from each other, there may be few opportunities for REITs to grow their asset base and hence, their profits.

## B. Pulp

Pulp and paper are often conceptualized as a single industry, but it is important to separate them and examine their different production processes for both pulp and paper. To make pulp, wood chips are cooked to separate its various components: cellulose fibers, lignin, and other substances such as hemicellulose. Cellulose is the major structural component of a plant's cell wall, providing both strength and structure.<sup>33</sup> Lignin is a polymer that acts as the glue between cellulose and hemicellulose components in trees.<sup>34</sup> Hemicellulose contributes to the plant wall and is used in the papermaking process.<sup>35</sup> Once separated from the lignin, the cellulose fibers form a pulp that is most commonly used as the raw material that makes paper products like tissue and paperboard.<sup>36</sup>

There are two major types of cellulosic wood pulp: dissolving pulp and fluff pulp. Dissolving pulp is a specialty grade of pulp that demonstrates the versatility of the cellulosic fiber. For example, cellulose derivatives like carboxymethylcellulose, ethylcellulose, and ethylpropylcellulose derived from dissolving pulp are used in everything from food to pharmaceutical products as natural thickening agents.<sup>37</sup> Cellulose acetate and cellulose acetate propionate are used as

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<http://investor.weyerhaeuser.com/2015-11-08-Weyerhaeuser-and-Plum-Creek-to-merge-creating-the-worlds-premier-timber-land-and-forest-products-company>.

<sup>31</sup> Mendell, *supra* note 8, at 32, 35.

<sup>32</sup> *Id.*

<sup>33</sup> John Nycz, *Knowing Where Your Paper Comes From: Sustainability is Critical*, WOODLAND PAPER (Jan. 12, 2019), <https://www.woodlandpaper.com/2019/01/where-paper-sustain/>.

<sup>34</sup> *International Paper v. Bridges*, 972 So.2d 1121, 1123 n.1 (La. 2008)

<sup>35</sup> *Id.* at 1123.

<sup>36</sup> See *What is Pulp?*, UPMPULP, <https://www.upmpulp.com/sustainable-pulp/what-is-pulp/> (last visited Dec. 8, 2020).

<sup>37</sup> See *Modified Celluloses*, INCHEM, <http://www.inchem.org/documents/jecfa/jecmono/v26je08.htm> (last visited Dec. 8, 2020).

an aerosol filtration medium that can be used in face masks as well as manufacturing optical frames.<sup>38</sup>

Fluff pulp is most known for its absorbent qualities, and therefore it is used in diapers, feminine products, and adult incontinence diapers.<sup>39</sup> Even tissues and toilet paper are made from fluff pulp, since cellulose fibers can hold between five to ten times their mass with no dripping.<sup>40</sup> In contrast to the absorbent qualities of cellulosic pulp, lignin is hydrophobic, which is why it must be removed before the cellulose fibers can be utilized.<sup>41</sup> However, lignin is not treated solely as a waste product. Scientists have developed a chemical process by which it can be converted into a gasoline substitute.<sup>42</sup> Since nearly every step of the paper production process involves ensuring that no lignin remains on the cellulose fibers, the lignin discharge can be diverted as a fuel source for the papermaking process.<sup>43</sup>

The highest grades of wood pulp are highly pure with a cellulose content over 90%.<sup>44</sup> They are not used to make paper but are instead dissolved in solvent in such a way that they can be spun into yarn or filament to manufacture textile products.<sup>45</sup> Traditionally, the commercial route to using cellulosic textiles was through axanthation-process using carbon disulfide as a solvent to produce viscose and rayon fibers, which did not dissolve in traditional solvents.<sup>46</sup> Scientists had to manipulate the xanthate-based process to make a pulp solution that they could make into longer fibers.<sup>47</sup> They used an ionic-based solution to develop an elastic, moisture-wicking, flexible material called lyocell that replaced cotton, which is heavily irrigated and uses significantly more water than timber.<sup>48</sup> The lyocell fiber discovery won Lenzing

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<sup>38</sup> See Dominique Thomas et al., *Composite Fibrous Filters for Nano-Aerosol Filtration: Pressure Drop and Efficiency Model*, 215 SEPARATION & PURIFICATION TECH. 557, 557 (2019) (explaining the aerosol filtration medium).

<sup>39</sup> Hubbe et al., *Enhanced Absorbent Products Incorporating Cellulose and Its Derivatives: A Review*, 8 BIORESOURCES 6556, 6556 (2013).

<sup>40</sup> *Id.* at 6556.

<sup>41</sup> *Id.* at 6559–60.

<sup>42</sup> See Jim Drury, *From sawdust to petrol*, REUTERS (Jan. 21, 2016, 6:17 AM), <https://www.reuters.com/article/us-belgium-sawdust-petrol/from-sawdust-to-petrol-idUSKCN0UZ19D>.

<sup>43</sup> See Monica Westman Svenselius, *Lignin – a super green fuel for fuel cells*, LINKÖPING UNIVERSITY (May 14, 2018), <https://liu.se/en/news-item/lignin-nytt-supergront-bransle-for-branslecell>.

<sup>44</sup> See Paul Flickinger et al., *Dissolving Pulp*, TAPPI 6 (Oct. 2, 2011), <https://www.tappi.org/content/events/11diss/flickinger.pdf>.

<sup>45</sup> *Id.*

<sup>46</sup> U.S. Patent No. 4,037,039 (filed July 19, 1977).

<sup>47</sup> U.S. Patent No. 3,335,023 (filed Aug. 8, 1967).

<sup>48</sup> Éva Borbély, *Lyocell, The New Generation of Regenerated Cellulose*, 5 ACTA POLYTECHNICA HUNGARICA 11, 12 (2008).

AG, Austria, the trademark holder of Tencel, a lyocell fiber, a European Award for the Environment for their efforts.<sup>49</sup>

### C. Paper

Though paper may be the sector most familiar to laymen, notions of the paper industry among the general public are woefully limited. Paper companies use wood pulp to generate two major products: graphic paper and paperboard. Graphic paper includes products such as newsprint, printing paper, and envelopes.<sup>50</sup> Paperboard, colloquially known as cardboard, is also considered a paper product.<sup>51</sup>

While increasing integrations of digital systems might seem to suggest that the paper industry is on its last legs, graphic paper is only one small subsector of the larger paper sector. Paper industry veterans understand that graphic paper demand has declined across the globe and have begun to adjust accordingly.<sup>52</sup> For example, though International Paper continues to produce graphic sheet paper, it has begun converting a number of its mills to focus on the production of “high quality whitetop linerboard and containerboard.”<sup>53</sup> Such machine conversions emphasize International Paper’s commitment to its packaging division over its traditional paper division.<sup>54</sup> And other companies are following in its footsteps. Another conglomerate, WestRock, has focused on growing its consumer packaging business, investing in producing corrugated pizza boxes and produce containers.<sup>55</sup> The growth of

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<sup>49</sup> *Rewarding Success in Eco-Innovation*, EUROPEAN COMM’N., [https://ec.europa.eu/environment/awards/winners\\_nominees\\_2000.html](https://ec.europa.eu/environment/awards/winners_nominees_2000.html) (last visited Dec. 9, 2020).

<sup>50</sup> *Industry Overview: Paper and Forest Products*, VALUE LINE, [https://valueline.com/Stocks/Industries/Industry\\_Overview\\_Paper\\_and\\_Forest\\_Products.aspx#.X\\_N0zmRKiDU](https://valueline.com/Stocks/Industries/Industry_Overview_Paper_and_Forest_Products.aspx#.X_N0zmRKiDU) (last visited Dec. 9, 2020).

<sup>51</sup> *Paper-Based Packaging*, AM. FOREST & PAPER ASS’N, <https://www.afandpa.org/our-products/paper-based-packaging/paperboard> (last visited Dec. 9, 2020).

<sup>52</sup> Mark Rushton, *Industry Trends in Graphic Paper*, PAPER360°, <https://paper360.tappi.org/2017/12/01/industry-trends-in-graphic-paper/> (last visited Dec. 9, 2020).

<sup>53</sup> *International Paper to Convert Riverdale Paper Machine*, PR NEWSWIRE (Sept. 22, 2017), <https://www.prnewswire.com/news-releases/international-paper-to-convert-riverdale-paper-machine-300524171.html>.

<sup>54</sup> Chris Hill, *Why Boxes Are the Future*, THE MOTLEY FOOL (Dec. 29, 2017, 9:24 PM), <https://www.fool.com/investing/2017/12/29/why-boxes-are-the-future.aspx>.

<sup>55</sup> *Corrugated Packaging*, WESTROCK, <https://www.westrock.com/products/corrugated-containers> (last visited Dec. 9, 2020).

packaging has allowed the industry as a whole to continue growing, even as the demand for graphic paper declines.<sup>56</sup>

The growth of the containerboard sector has had environmental implications. Containerboard is the single most recycled packaging material in the United States, amounting to 25% of all materials.<sup>57</sup> As many as 88% of corrugated packaging containers are recycled.<sup>58</sup> Given that corrugated containers are already made in part from recycled paper, they represent 65.7% of all the municipal solid waste that is recycled, more than any other material.<sup>59</sup> In contrast, plastic packaging materials, which represent 30% of the packaging market, are recycled only 4% of the time.<sup>60</sup> This means most containerboard, which is generally made in part from recycled fibers, is being thrown back into the Kraft process, generating further recycled fibers.<sup>61</sup> The dominance of containerboard has led to increased circularity in the Industry.

Paper scientists are still focused on inventing more than process control technology, knowing their traditional business model is “cratering and dying.”<sup>62</sup> Product development continues, albeit more slowly than process innovation, and the slow death of their traditional newsprint-and-loose leaf business model has forced paper scientists to turn creative. For example, Nomex sheets made from fire-retardant grafted cellulose are so heat and fire-resistant that they are used in apparel by NASCAR drivers, fighter pilots, and even by the U.S. Space Program.<sup>63</sup> On the packaging front, manufacturers have increasingly focused on digitization, such as packaging material that can track storage conditions or detect any tampering.<sup>64</sup> And of course paper straws have been profitable for the paper sector; the market is projected

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<sup>56</sup> Peter Berg & Oskar Lingqvist, *Pulp, Paper, and Packaging in the Next Decade: Transformational Change*, MCKINSEY & CO. (Aug. 7, 2019), <https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/pulp-paper-and-packaging-in-the-next-decade-transformational-change>.

<sup>57</sup> AM. FOREST & PAPER ASS'N, *supra* note 51.

<sup>58</sup> *Id.*

<sup>59</sup> *Advancing Sustainable Materials Management: 2017 Fact Sheet*, EPA (Nov. 2019), [https://www.epa.gov/sites/production/files/2019-11/documents/2017\\_facts\\_and\\_figures\\_fact\\_sheet\\_final.pdf](https://www.epa.gov/sites/production/files/2019-11/documents/2017_facts_and_figures_fact_sheet_final.pdf).

<sup>60</sup> *Id.*

<sup>61</sup> *Id.*

<sup>62</sup> Michael Rosenwald, *Print is Dead. Long Live Print.*, COLUM. JOURNALISM REV. (2016), [https://www.cjr.org/special\\_report/print\\_analog\\_comeback.php](https://www.cjr.org/special_report/print_analog_comeback.php).

<sup>63</sup> *When the Heat is On, Nomex® Delivers*, DUPONT, <https://www.dupont.com/brands/nomex.html> (last visited Jan. 4, 2021).

<sup>64</sup> *Value Creation in the Digital Paper and Packaging Business*, SAP (2016), [https://technology.risiinfo.com/sites/technology.risiinfo.com/files/Digital\\_Whitepaper\\_Paper\\_and\\_Packaging.pdf](https://technology.risiinfo.com/sites/technology.risiinfo.com/files/Digital_Whitepaper_Paper_and_Packaging.pdf).

to grow from \$585 million in 2019 to \$1.6 billion by the end of 2020.<sup>65</sup> Paper may appear the obvious underdog in the Internet era, but paper products continue to remain relevant.

## II. THE PRODUCTION CYCLE AND THE CIRCULAR ECONOMY

### A. The Production Cycle

Wood is the primary material used by all three segments of the Industry, though a number of other materials are used and recycled throughout the production cycle.<sup>66</sup> The reuse of materials is why the Industry is referred to as a circular economy, a system that maximizes its use of resources and reduces waste. A circular economy stands in contrast to a linear economy by reusing the waste itself in other parts of the production cycle rather than disposing of it.<sup>67</sup> Like a loop, every residual component is reused in other capacities.

In the papermaking context, maximizing the use of resources means “improving the fiber yield (i.e. using every part of the tree), using renewable, carbon-neutral biomass, reusing and recycling water in the manufacturing process, producing renewable energy on-site in lieu of purchasing energy, reducing and optimizing the use of non-renewable resources, providing manufacturing residuals and byproducts for other uses, etc.”<sup>68</sup> Optimizing the circular economy is the Industry’s best way of remaining sustainable and environmentally friendly, despite the heavy extraction of natural resources that the production process requires.

All three aspects are present during what is known as the Kraft pulping process and papermaking:

1. Wood Preparation: Bark is removed from the wood logs and then chipped.

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<sup>65</sup> Concern over the effect that plastic straw usage was having on the environment, customers are increasingly looking for more eco-friendly substitutions. Since plastic straws are not biodegradable, customers are increasingly turning to paper straws as a more sustainable alternative, and the market is projected to have a compounded annual growth rate of 20%. *Paper Straw Market to reach US \$1.60 Billion by 2025*, GLOBE NEWSWIRE (Aug. 18, 2020), <https://www.globenewswire.com/news-release/2020/08/18/2079684/0/en/Paper-Straw-Market-to-reach-US-1-60-billion-by-2025-Global-Insights-on-Key-Stakeholders-Growth-Drivers-Restraints-Challenge-Recent-Initiatives-and-Business-Opportunities-Adroit-Mar.html>.

<sup>66</sup> NAT’L. RSCH. COUNCIL, *supra* note 1, at 79.

<sup>67</sup> See Jerry Schwartz, *Contributing to the Circular Economy: The Paper and Wood Products Industry*, AM. FOREST & PAPER ASS’N. (Aug.15, 2019).

<sup>68</sup> *Id.*

2. Cooking: The wood chips are cooked in an alkaline white liquor containing sodium hydroxide and sodium sulfide, resulting in the removal of lignin and the separation and transformation of cellulose to a fiber form.
3. Washing: The cellulose is thoroughly washed to remove any remaining lignin or additives from the fiber and also the spent chemicals from the cooking. The spent liquor thus separated from the cellulosic fiber is called black liquor. The black liquor is converted back into cooking white liquor in the chemical recovery process; the chemical recovery process also uses the energy value of the lignin to generate steam to generate power and to be used in the process.
4. Screening: All knots and tangles in the fiber are removed from the pulp.
5. Bleaching: In a two-step process, wherein the washed pulp is treated with a combination of alkaline solution and chlorine-free bleaching chemicals to brighten the pulp and to ensure that no lignin remains in the pulp.
6. Paper Production: Fibers are mechanically bonded to each other and any additional chemicals to provide special optical, surface and strength properties like color and porosity and tear strength. The fibers are sent through a series of hot rollers to dry (dryer cans) and calendared to a smooth surface to form paper.<sup>69</sup>

Circularity in the Industry takes three primary forms: resource management, energy management, and waste management.<sup>70</sup> Resource management requires proper cultivation of timber resources and the maximization of those resources to as many diversified products as possible and minimizing wood fiber losses.<sup>71</sup> Energy management also concerns fibers, ensuring that pulp and paper production do not utilize more water or energy than necessary.<sup>72</sup> Proper waste management ensures that the final disposal at the end of the process is as minimal as possible.<sup>73</sup>

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<sup>69</sup> *The Pulp and Paper Industry*, SEMANTIC SCHOLAR 7 (last visited Dec. 7, 2020).

<sup>70</sup> Michael Has et al., *Design and Management for Circularity – the Case of Paper*, WORLD ECONOMIC FORUM 13 (Jan. 2016).

<sup>71</sup> *Id.*

<sup>72</sup> *Id.*

<sup>73</sup> *Id.*

Resource management involves preserving as much of the raw material and re-introducing it into the process. Ideally, circularity would involve utilizing fiber already extracted to produce new products. Reusing the fiber would involve separating it from all other materials, processing it until clear of contaminants, and then, if in a mill that handles both virgin and recycled fiber, adding it to virgin wood pulp. Under this approach, recaptured fibers, when properly processed, can be a valuable resource.

Energy management is particularly critical for the paper industry because every step of the papermaking process requires large blocks of energy to conduct the necessary manufacturing processes. According to the Department of Energy, large process areas include “bleaching, liquor evaporation, stock preparation, paper drying, etc.”<sup>74</sup> Most mills tend to burn leftover wood waste such as logs or chips to generate energy, though some older Kraft mills may continue to use fossil fuels.<sup>75</sup> Newer mills are generally able to derive all necessary steam and electrical energy from the black liquor, sludge, and wood waste produced by the papermaking process.<sup>76</sup>

In the waste management context, circularity is evident primarily in the regeneration of the sodium hydroxide and sodium sulfide in the white liquor so they can be reused in the black liquor to prevent them from being discharged unnecessarily.<sup>77</sup> Additionally, the processed water drained from the cellulose undergoes filtration and is reintroduced.<sup>78</sup> The organic and inorganic material in the water is also recovered.<sup>79</sup> The wastewater generated by the paper production process is treated and then reused.<sup>80</sup> The sludge cleared from the wastewater goes into the boiler and used as an energy source.<sup>81</sup>

The Industry often comes under scrutiny for its environmental practices.<sup>82</sup> Unlike most industries, however, the foundation of the Industry is a renewable raw material, and its manufacturing process is as circular as possible.

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<sup>74</sup> Robert B. Kinstrey & David White, *Pulp and Paper Industry Energy Bandwidth Study*, JACOBS ENGINEERING GROUP 18 (Aug. 2006).

<sup>75</sup> NAT’L ACAD. OF ENG’G, *THE ECOLOGY OF INDUSTRY: SECTORS AND LINKAGES* 110–11 (Deanna J. Richards & Greg Pearson eds., 1998).

<sup>76</sup> *Id.* at 111.

<sup>77</sup> *Id.* at 106.

<sup>78</sup> *See* Circular Utilization Method in Pulping and Papermaking Processes with Straw, U.S. Patent No. 8,778,135 col. 31, l. 21-41 (filed Mar. 11, 2011) (issued July 15, 2014).

<sup>79</sup> Kinstrey & White, *supra* note 74, at 48.

<sup>80</sup> ’135 Patent fig.3, 4.

<sup>81</sup> NAT’L ACAD. OF ENG’G, *supra* note 75, at 110.

<sup>82</sup> *Id.* at 131–32.

## B. The Future of the Circular Economy

The above statistics ignore the elephant in the room: what happens to the Industry during the pandemic and afterwards? Worldwide, over 83 million cases and 1.8 million confirmed deaths of COVID have been reported to the World Health Organization as of the time of this writing.<sup>83</sup> Aside from the human toll, no pandemic has had such an impact on the modern global economy as COVID.<sup>84</sup> The nations with the most reported cases represent approximately 50% of global manufacturing exports.<sup>85</sup> The impact on global supply chains has severely affected the Industry.<sup>86</sup> Some of these disruptions have been negative and will continue to be an ongoing problem for the Industry. However, the Industry responded quickly, particularly on the container board side, and was able to mitigate the losses that could have ensued with the economy on uncertain ground.

From the Industry perspective, executives were asked to rank their greatest concerns with respect to COVID. The following were the top seven fears among respondents:

1. The financial impact on operations, liquidity, and capital resources;
2. The potential of a global recession;
3. The effect on workforce and its productivity;
4. A decline in consumer confidence and consumption;
5. A disruption to supply chains;
6. Difficulty funding future projects; and
7. Uncertainty limiting management's capacity to make informed decisions.<sup>87</sup>

The list emphasizes the comprehensive nature of the coronavirus epidemic and how it continues to affect every part of human life and decision-making. A typical contingency plan would allow management to develop risk management models at every step of the production life

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<sup>83</sup> WHO *Coronavirus Disease (COVID-19) Dashboard*, WORLD HEALTH ORGANIZATION, <https://covid19.who.int/> (last visited Jan. 4, 2021).

<sup>84</sup> ECONOMICS IN THE TIME OF COVID-19 1–2 (Richard Baldwin & Beatrice Weder di Mauro eds., 2020).

<sup>85</sup> *Id.*

<sup>86</sup> *The Impacts of COVID-19 on the Forest Sector: How to Respond?*, FOOD AND AGRIC. ORG. OF THE UNITED NATIONS 2 (Apr. 23, 2020), <http://www.fao.org/3/ca8844en/CA8844EN.pdf>.

<sup>87</sup> *COVID-19: What it means for forest, paper and packaging companies*, PWC (Apr. 22, 2020), <https://www.pwc.com/us/en/library/covid-19/coronavirus-impacts-forest-paper-packaging.html>.

cycle. COVID, however, requires management to balance liquidity and capital, global markets, widespread school and workplace closures, quarantines, travel restrictions, and human health and wellbeing on top of the regular challenges of keeping the production process running as efficiently as possible.

In addition to a contingency plan, the Industry can mitigate losses by diversifying their investments. Since the circular value chain depends on “controlling finite stocks and balancing renewable resource flows,” volatility in the consumer products market will affect every aspect of the product life cycle.<sup>88</sup> Many companies have confronted the difficult operating climate by diversifying their holdings to invest in each step of the production process.<sup>89</sup> Doing so has proven successful for those companies. For example, the CEO of Sappi, a South African pulp and paper company, reported that the company expected 2019 full year results to exceed those of 2018, despite temporary underperformance resulting from “current weak graphic paper markets and paper pulp prices which remain high in Europe and North America.”<sup>90</sup>

Companies in the Industry are not the only ones who could benefit from diversified Industry investment. Approximately \$1.9 trillion, foreign exposure through foreign equities represent 11% of equity portfolios in the United States.<sup>91</sup> Evidence shows that during times of market uncertainty, investors have a preference for companies that are internationally diversified.<sup>92</sup> However, controlled studies demonstrate that investors do not necessarily obtain the benefits of international diversification without understanding the weight of their investments “country by industry.”<sup>93</sup> True diversification in the Industry involves understanding the circularity of the production cycle. For example, International Paper’s (“IP”) disappointing third quarter in 2019 was primarily the result of the decline in sales and profit in the industrial

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<sup>88</sup> Has et al., *supra* note 70, at 7.

<sup>89</sup> *Implications of the COVID-19 Pandemic for Global Sustainable Finance: AN INITIAL FRAMEWORK FOR RESPONSE STRATEGIES*, UNITED NATIONS ENV’T PROGRAMME 6 (Apr. 2020), [https://unepinquiry.org/wp-content/uploads/2020/05/Implications\\_of\\_the\\_COVID-19\\_Pandemic\\_for\\_Global\\_Sustainable\\_Finance.pdf](https://unepinquiry.org/wp-content/uploads/2020/05/Implications_of_the_COVID-19_Pandemic_for_Global_Sustainable_Finance.pdf).

<sup>90</sup> *Diversification pays off for paper and pulp heavyweight*, EASTERN CAPE INDUS. AND BUS. NEWS (Feb. 20, 2019), <https://www.easterncapeindustrialnews.co.za/news/diversification-pays-off-for-paper-and-pulp-heavyweight>.

<sup>91</sup> Fang Cai & Francis E. Warnock, *International Diversification at Home and Abroad* 20 (Nat’l Bureau of Econ. Rsch., Working Paper No. 12220, 2006), <https://www.nber.org/papers/w12220.pdf>.

<sup>92</sup> *Id.* at 13.

<sup>93</sup> *Id.*

packaging segment.<sup>94</sup> But despite lost demand from e-commerce giants like Amazon, IP experienced a successful holiday season as other segments, such as white paper, have held strong.<sup>95</sup> IP even announced an increase in its dividend payout—a bullish development.<sup>96</sup>

IP is the largest and most influential company in the Industry, and it therefore has the ability to invest in a wide range of forest products. For most people, the decline in graphic paper has been devastating.<sup>97</sup> For example, operations at Verso paper mills in Minnesota and Wisconsin were both suspended as the corporation explored options other than producing graphic paper.<sup>98</sup> Verso justified the closure by citing a study that found that “North American printing & writing demand fell by 38% year-over-year in April, and operating rates are expected to drop well below 70% during the second quarter.”<sup>99</sup> Verso’s Wisconsin Rapids mill was once the largest manufacturer of paper in the world.<sup>100</sup> With the demand for printed paper already depressed, coronavirus is certain to devastate this sector further, particularly as more people rely on the Internet to work and communicate.

### III. SUSTAINABILITY V. SUSTAINABILITY-ORIENTED INNOVATION

Sustainable long-term activism can be unique in the modern corporation, which is often characterized by collective action problems or motivated by the maximization of financial returns in the short-term.<sup>101</sup> In *The Modern Corporation and Private Property*, Adolf Berle and Gardiner Means argued that the separation of ownership and control and the dispersal of shareholders meant inadequate scrutiny of management decisions.<sup>102</sup> In large corporations with a large number of shareholders, allowing shareholders to act as decision-making owners

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<sup>94</sup> Andrew Barber, *Paper Producers Stabilize, But Risks Remain*, THE MOTLEY FOOL (Nov. 13, 2019, 9:22 AM), <https://www.fool.com/investing/2019/11/13/paper-producers-stabilize-but-risks-remain.aspx>.

<sup>95</sup> *Id.*

<sup>96</sup> *Id.*

<sup>97</sup> Peter Kendall, *A Warning from Wisconsin*, THE WASHINGTON POST (July 30, 2020), <https://www.washingtonpost.com/business/2020/07/30/wisconsin-paper-mill-shutdown-coronavirus/?arc404=true>.

<sup>98</sup> *Verso Announces Necessary Actions to Offset Unprecedented Market Decline Due to COVID-19*, VERSO CORPORATION (June 9, 2020), <http://investor.versoco.com/2020-06-09-Verso-Announces-Necessary-Actions-to-Offset-Unprecedented-Market-Decline-Due-to-COVID-19>.

<sup>99</sup> *Id.*

<sup>100</sup> Kendall, *supra* note 97.

<sup>101</sup> Kent Greenfield, *The Puzzle of Short-Termism*, 46 WAKE FOREST L. REV. 627, 632 (2011).

<sup>102</sup> See generally ADOLF A. BERLE & GARDINER C. MEANS, *THE MODERN CORPORATION AND PRIVATE PROPERTY* (1932).

is near-impossible.<sup>103</sup> Corporations are therefore governed by management (directors and officers) rather than by the owners (the shareholders) unless those shareholders have enough institutional power to influence the corporation's decision-making. Powerful shareholders are not inherently bad. Under the Berle-Means model, the main conflict in a corporation is the tension between shareholders and management.<sup>104</sup> Concentrating power in the hands of well-informed shareholders allows supervision of management decision-making.<sup>105</sup>

The issue in most modern corporations, including in the Industry, is that empowering individual shareholders concentrates power in the hands of institutional shareholders.<sup>106</sup> Generally, institutional shareholders hold their stocks for less than a year on average and are focused on short-term gains, even if those gains come with long-term costs for the company.<sup>107</sup> So the simple solution of empowering shareholders that Berle and Means advocated is complicated by the short-term focus of many institutional shareholders. They may not be interested in "expensive investments that are difficult for the market to process," even if those investments are designed to preserve the circularity of the Industry.<sup>108</sup>

Despite those short-term pressures, however, rising trends toward socially responsible investing (known as "SRI" or "ESG investing") presents the Industry with promising opportunities. In particular, the Industry can negotiate two approaches when it comes to stewardship and environmental sustainability: (1) conservation of resources and (2) innovation systems that "explore potential paths of the sustainability transformation."<sup>109</sup> But simply touting sustainability efforts is no longer enough for investors; a company must detail a plan of action inspired by its sustainable ethos.<sup>110</sup> To be sure, some investors have become cynical about promises of sustainable capitalism, largely due to a concern that such affirmations are merely empty promises driven by

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<sup>103</sup> See Usha Rodrigues, *Corporate Governance in an Age of Separation of Ownership from Ownership*, 95 MINN. L. REV. 1822, 1827–29 (2011).

<sup>104</sup> See *id.* at 1826–27.

<sup>105</sup> See *id.* at 1827–28.

<sup>106</sup> See *id.* at 1828.

<sup>107</sup> See *id.* at 1831, 1833.

<sup>108</sup> *Id.* at 1847.

<sup>109</sup> Andreas Pyka, *Dedicated Innovation Systems to Support the Transformation Towards Sustainability: Creating Income Opportunities and Employment in the Knowledge-Based Digital Bioeconomy*, 3 J. OPEN INNOVATION: TECH., MKT., & COMPLEXITY at 3 (Dec. 28, 2017).

<sup>110</sup> Robin Döttling & Sehoon Kim, *Sustainability preferences under stress: Mutual fund flows during COVID-19*, VOXEU (Aug. 19, 2020), <https://voxeu.org/article/investment-preferences-under-stress>.

financial objectives, rather than a sincere interest in follow-through.<sup>111</sup> Consumers and investors have developed a new social consciousness during the COVID era, and companies that tout their environmental bona fides without actually acting upon them are no longer palatable to investors and consumers.<sup>112</sup>

This part explores how the Industry can adopt genuine sustainability improvements and capitalize by doing so. The financial incentives for companies to adopt socially responsible practices poses promise for society and the environment. In the Industry's context, active resource, energy, and waste management is imperative since cultivating timberland and producing pulp and paper products are water and energy-intensive processes.<sup>113</sup>

### A. Sustainability

A valuable long-term partner of the Industry is the American Forest and Paper Association, the industry trade association. Its members come together to define environmental, health, and safety principles to be adopted on timberland and in pulp and paper facilities.<sup>114</sup> Public commitments to environmental stewardship can assuage the fears of those who believe the ownership of forestland by REITs or other specialized management vehicles are bad for the environment, particularly if the land is earmarked for commercial use.<sup>115</sup>

Even if earmarked for commercial use, paper companies monitor forest growth very carefully, and it appears that paper companies do not engage in sustainable forestry practices merely to curry favor with environmentalists. For example, like most paper companies, Weyerhaeuser clearly sees sustainability and forest management as crucial to its bottom line.<sup>116</sup> The company uses planning models that

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<sup>111</sup> *Id.*

<sup>112</sup> Maria Coronado Robles, *The Coronavirus Era: From Sustainability to Purpose*, BEAUTY PACKAGING (July 24, 2020), [https://www.beautypackaging.com/issues/2020-07-01/view\\_columns/the-coronavirus-era-from-sustainability-to-purpose/](https://www.beautypackaging.com/issues/2020-07-01/view_columns/the-coronavirus-era-from-sustainability-to-purpose/).

<sup>113</sup> NATIONAL ACADEMY OF ENGINEERING AND NATIONAL RESEARCH COUNCIL, INDUSTRIAL ENVIRONMENTAL PERFORMANCE METRICS: CHALLENGES AND OPPORTUNITIES 141 (1999), <https://www.nap.edu/read/9458/chapter/9>.

<sup>114</sup> A. Douglas Armstrong et al., *The Pulp and Paper Industry*, in THE ECOLOGY OF INDUSTRY: SECTORS AND LINKAGES 101, 132 (Deanna J. Richards and Greg Pearson ed., 1996), <https://www.nap.edu/read/5793/chapter/7>.

<sup>115</sup> Kathryn Fernholz et al., *TIMOs & REITs What, Why, & How They Might Impact Sustainable Forestry*, DOVETAIL PARTNERS 8 (2007), [https://dovetailinc.org/report\\_pdfs/2007/dovetailtimoreit0507wo-1.pdf](https://dovetailinc.org/report_pdfs/2007/dovetailtimoreit0507wo-1.pdf).

<sup>116</sup> CENTER FOR CLIMATE AND ENERGY SOLUTIONS, WEATHERING THE STORM: BUILDING BUSINESS RESILIENCE TO CLIMATE CHANGE 36 (2013), <https://www.c2es.org/site/assets/uploads/2013/07/weathering-the-storm-full-report.pdf>.

incorporate environmental data.<sup>117</sup> These planning models also incorporate risk management analyses that rely on close monitoring of conditions that impact timberlands.<sup>118</sup> The company also “updates its forest timber inventories, growth projections, harvest schedules, and planting activities to account for potential and actual annual losses from extreme weather.”<sup>119</sup> Sustainability, climate change, and weather patterns are factors Weyerhaeuser must plan for in its long-term business models.<sup>120</sup>

The Industry is also committed to reusing its own waste product as a resource, in addition to its meticulous stewardship of forestland, but most companies simply focus on sustainability and improving their business models. Most companies publicize their efforts at environmentalism and sustainable practices. Weyerhaeuser, for example, has begun to publish its annual reports in line with the guidelines recommended by the Global Reporting Initiative, an influential initiative of the Coalition for Environmentally Responsible Economies.<sup>121</sup> Its guidelines emphasize the three elements of triple bottom line reporting: social, environmental, and financial/economic.<sup>122</sup> International Paper publishes detailed reports on sustainability, reducing emissions, and its stewardship of forests and waters.<sup>123</sup> During COVID, International Paper has developed masks, collected food, and donated boxes, and it has also collected donations to food banks.<sup>124</sup>

Socially responsible corporate action is laudable, but true sustainability requires the Industry to demonstrate a commitment to the environment beyond merely optimizing its own processes. Experts broadly defined this as “improvements for social good, not just ‘green’ initiatives.”<sup>125</sup> Sustainability-oriented innovation requires companies to develop products in the manner of a start-up or a disrupter, valuing agility and creating an innovative culture devoted to environmental and social problem-solving.<sup>126</sup> Given the traditional nature of the Industry,

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<sup>117</sup> *Id.*

<sup>118</sup> *Id.*

<sup>119</sup> *Id.*

<sup>120</sup> *Id.* at 90.

<sup>121</sup> *Weyerhaeuser Publishes 2003 Sustainability Report*, WEYERHAEUSER (June 2, 2004), <http://investor.weyerhaeuser.com/2004-06-02-Weyerhaeuser-Publishes-2003-Sustainability-Report>.

<sup>122</sup> *Id.*

<sup>123</sup> *Planet*, INT’L PAPER (2020), <http://www.internationalpaper.com/planet>.

<sup>124</sup> *International Paper COVID-19 Pandemic Response*, INT’L PAPER (2020), <http://www.internationalpaper.com/newsroom/covid-19>.

<sup>125</sup> Thijs H.J. Geradts & Nancy M.P. Bocken, *Driving Sustainability-Oriented Innovation*, MIT SLOAN MGMT. REV. (Nov. 28, 2018), <https://sloanreview.mit.edu/article/driving-sustainability-oriented-innovation/>.

<sup>126</sup> *Id.*

this requires a new approach to the entire business. Particularly during the COVID era, when investors are committed to socially responsible investments and health, innovation of new technologies are more important than offering “social signals and preferences.”<sup>127</sup>

## B. Sustainability-Oriented Innovation: Pulp and Paper Initiatives

Weyerhaeuser and International Paper are two of the largest forest, pulp, paper, or packaging companies in the world, each having had a hand in the growth of each Industry segment.<sup>128</sup> While they have implemented sustainable practices, their efforts are extremely limited when compared to some of their counterparts in the Europe, who are more focused on developing new products rather than mere environmental stewardship. SCA, a Swedish forestry and paper company, raised SEK 1.5 billion by issuing a “green” bond, to be spent on environmental projects focused on clean and renewable energy and efficiency.<sup>129</sup> SCA also commissions independent environmental status reports every year, where it explains its project portfolio for the upcoming year and how it hopes to capitalize on market trends to develop new high-quality paper products that are both profitable and sustainable.<sup>130</sup> Stora Enso, a Finnish company specializing in paper and packaging products, has had its environmental efforts celebrated by the World Business Council for Sustainable Development.<sup>131</sup> Stora Enso is noted for its agile and innovative approach to producing sustainable products, including working with start-ups and developing cooperatives with other companies.<sup>132</sup>

Most notably, Stora Enso has committed to a “long-term target to have 15% of the annual revenue coming from new products and services which didn’t exist in our portfolio three years ago.”<sup>133</sup> This illustrates the difference between sustainability-based innovation and sustainable

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<sup>127</sup> Döttling & Kim, *supra* note 110.

<sup>128</sup> Jim Kenny, *The Top Ten Global Paper Companies: Currencies Lift Europeans up the Top 10*, TAPPI (June 2004), <https://imisrise.tappi.org/tappi/products/04/jun/04junoe04.aspx>.

<sup>129</sup> *SCA First Swedish Company to Issue “Green” Bond*, PULP & PAPER CANADA (Mar. 26, 2014), <https://www.pulpandpapercanada.com/sca-issues-green-bond-1002979998/>.

<sup>130</sup> *SCA Annual Report 2019*, SCA (2019), <https://www.sca.com/en/about-us/Investors/financial-archive/annual--and-sustainability-reports/>.

<sup>131</sup> *Stora Enso’s Sustainability Report Rated Among Top Ten Globally*, STORA ENSO (Oct. 15, 2019), <https://www.storaenso.com/en/newsroom/press-releases/2019/10/stora-ensos-sustainability-report-rated-among-top-ten-globally>.

<sup>132</sup> *Accelerating Innovation Together With Start-ups*, STORA ENSO (Apr. 22, 2020), <https://www.storaenso.com/en/inspiration-centre/renewable-future-blog/2020/4/accelerating-innovation-together-with-start-ups>.

<sup>133</sup> *Id.*

practices; Stora Enso prioritizes the former, while most United States companies tend to focus on the latter. Stora Enso's commitment to innovating new products is a step beyond, given that they are committing not only to caring for the environment but to creating products that aid the environment as well.<sup>134</sup> Stora Enso's strategy of developing new sustainable products makes the nebulous commitment to sustainability more concrete to investors.

Another important actor is Sodra Cell, a Swedish company that produces more green energy than it uses and subsequently sells its surplus energy to other companies.<sup>135</sup> The plan is to develop new biofuels that can support full scale production lines for fossil fuel-free products.<sup>136</sup> The project is funded by the Norwegian Ministry of Petroleum and Energy.<sup>137</sup> It is also using the technology in paper mills to ensure they are entirely fossil-free, reduce water consumption, and ensure emissions will be lower per ton of produced product.<sup>138</sup> And finally, Sodra is developing a project to grow Sweden's forestland by 1% each year.<sup>139</sup>

Smurfit Kappa, an Irish company specializing in corrugated packaging, developed a series of products designed to facilitate the transition back to school and the workplace after COVID.<sup>140</sup> Working with educators and professionals, the company launched a portfolio of corrugated products to create creative dividers in schools and offices.<sup>141</sup> Its initial prototype was containerboard workspace dividers to aid workers who work in close proximity to practice social distancing measures.<sup>142</sup> These were so popular that the company eventually began adapting the divider for additional purposes, including the separation of

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<sup>134</sup> *Id.*

<sup>135</sup> *How Green Can We Go? Untapping the Huge Potential of the Pulp Mill*, PULP-PAPERWORLD.COM (Nov. 22, 2019, 8:48 AM), <http://www.pulp-paperworld.com/european-news/itemlist/tag/s%C3%B6dra?start=10>.

<sup>136</sup> Alan Sherrard, *Statkraft and Södra to build advanced biofuel demonstration plant in Norway*, BIOENERGY INTERNATIONAL (Dec. 15, 2017), <https://bioenergyinternational.com/biofuels-oils/statkraft-sodra-build-advanced-biofuel-demonstration-plant-norway>.

<sup>137</sup> *Id.*

<sup>138</sup> *Södra's pulp mill in Värö is now reality*, PAPER INDUSTRY WORLD (Nov. 22, 2016), <https://www.paperindustryworld.com/sodras-pulp-mill-varo-now-reality-2/>.

<sup>139</sup> *Id.*

<sup>140</sup> *Smurfit Kappa Launches Corrugated Solutions Portfolio to Help COVID-19 Affected Communities*, INK WORLD (Apr. 9, 2020), [https://www.inkworldmagazine.com/contents/view\\_Content-microsite/2020-04-09/smurfit-kappa-launches-corrugated-solutions-portfolio-to-help-covid-19-affected-communities/](https://www.inkworldmagazine.com/contents/view_Content-microsite/2020-04-09/smurfit-kappa-launches-corrugated-solutions-portfolio-to-help-covid-19-affected-communities/).

<sup>141</sup> *Id.*

<sup>142</sup> *Cardboard Workspace Dividers*, SMURFIT KAPPA, <https://www.smurfitkappa.com/products-and-services/displays/cardboard-workspace-divider> (last visited Dec. 9, 2020).

patients in hospital wards.<sup>143</sup> The company also used its expertise in corrugated paperboard to construct beds for emergency medical areas.<sup>144</sup> Agility and a refusal to be inert allowed Smurfit Kappa to use its expertise to develop a sustainability-oriented product focused on community health during a global crisis.

Klabin, Brazil's largest packaging paper producer, created a crisis committee to develop a strategy to combat COVID.<sup>145</sup> According to the Brazilian Association of the Personal Hygiene Products, Perfume, and Cosmetics, the thickening agent used in hand sanitizing gel was exponentially rising in price as COVID continued.<sup>146</sup> Klabin began testing alternatives to Carbopol, the primary component in the manufacturing of gel alcohol.<sup>147</sup> Within two weeks, the company developed a micro-fibrillated cellulose from pine and eucalyptus that resembled gel that could replace Carbopol in the emulsification process of creating hand sanitizer.<sup>148</sup> The director of Research and Development at Klabin, Corina Godoy Cunha, explained that the invention of the novel formula was the result of Apoteka's belief that it had a social responsibility to do its part in the fight against the coronavirus.<sup>149</sup>

In North America, the Massachusetts Institute of Technology partnered with 3M to develop a paper-based COVID test that could easily be mass produced.<sup>150</sup> The National Institute of Health's National Institute of Biomedical Imaging and Bioengineering included this

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<sup>143</sup> "Designed to Help", *Smurfit Kappa's New Range of Solutions to Tackle the Covid-19*, EUROFRESH DISTRIBUTION (Apr. 30, 2020), <https://www.eurofresh-distribution.com/news/designed-help-smurfit-kappas-new-range-solutions-tackle-covid-19>.

<sup>144</sup> *Id.*

<sup>145</sup> Press Release, Klabin Press Office, Klabin Adopts New Technology in Its Mills to Help Combat COVID-19, (Apr. 20, 2020), <https://klabin.com.br/en/newsroom/press-release/klabin-adopts-new-technology-in-its-mills-to-help-combat-covid-19/>.

<sup>146</sup> See Katia Pichelli, *Scientists Obtain a Thickening Agent from Pine and Eucalyptus Cellulose to Produce Alcohol Hand Sanitizer*, EMBRAPA (Apr. 22, 2020), <https://www.embrapa.br/en/busca-de-noticias/-/noticia/51565414/scientists-obtain-a-thickening-agent-from-pine-and-eucalyptus-cellulose-to-produce-alcohol-hand-sanitizer>.

<sup>147</sup> Press Release, Klabin Press Office, Klabin Utiliza Celulose como Matéria-Prima na Produção de Álcool em Gel [Klabin Uses Cellulose as a Raw Material in the Production of Gel Alcohol] (Apr. 24, 2020), <https://klabin.com.br/sala-de-noticias/press-release/klabin-utiliza-celulose-como-materia-prima-na-producao-de-alcool-em-gel/>.

<sup>148</sup> *Id.*; Pichelli, *supra* note 146.

<sup>149</sup> Press Release, *supra* note 147.

<sup>150</sup> Conor Hale, *3M Pairs with MIT to Develop a Paper-Based Coronavirus Diagnostic Test*, FIERCE BIOTECH (July 14, 2020), <https://www.fiercebiotech.com/medtech/3m-pairs-mit-to-develop-a-paper-based-coronavirus-diagnostic-test>.

initiative in its Rapid Acceleration of Diagnostics Tech program, developed to combat COVID.<sup>151</sup> The test is cellulose-based and uses a paper strip—rather than a plastic device—to deliver results.<sup>152</sup>

FPInnovations, a private Canadian company that specializes in all aspects of the forest sector, completed the first phase of the development of a fully biodegradable and disposable face mask using wood fibers.<sup>153</sup> As described:

The cellulosic filter media is the middle layer of a three-layer mask, is made from sustainable wood fibres, and is suitable for single-use face masks for public use. Current single-use personal masks are made from petroleum-based plastics. The average filtration efficiency of this new cellulosic filter media is currently at 60 per cent, surpassing the average filtration efficiency of a typical cloth mask, which is approximately 30 per cent. FPInnovations' research efforts now aim to further improve the filtration efficiency of the media to meet requirements for surgical masks, which may lead to potential new uses of the filter medium such as in-air filtration systems.<sup>154</sup>

FPInnovations' involvement thus reflects sustainability-oriented innovation of new products. And not only did the firm contribute to COVID-related needs, but they expanded possibilities for new filtration mediums, which could have important public health benefits.

The examples in this section evidence a number of consequential sustainability-oriented innovations stemming from the pulp and paper industry. Importantly, they also reflect a global response. Even if the United States lags behind other countries in this domain, there are positive trends that indicate a global commitment to true sustainability. And pulp and paper companies are not the only ones engaging in socially responsible innovation; timber companies are also offering positive contributions.

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<sup>151</sup> Omar Ford, *Could Paper Be the Key Behind Developing a Rapid COVID-19 Test?*, MDDI (July 14, 2020), <https://www.mddionline.com/covid-19/could-paper-be-key-behind-developing-rapid-covid-19-test>.

<sup>152</sup> See Hale, *supra* note 150.

<sup>153</sup> See FPInnovations, *FPInnovations completes first-phase development of biodegradable face masks*, PULP & PAPER CAN. (Sept. 16, 2020), <https://www.pulpandpapercanada.com/fpinnovations-completes-first-phase-development-of-biodegradable-face-masks/>.

<sup>154</sup> *Id.*

### C. Sustainability-Oriented Innovation: Major Timber Initiatives

An illustrative example of sustainability-oriented innovation in the timber segment is Weyerhaeuser's response to the explosion of Mount St. Helens. On May 18, 1980, Mount St. Helens erupted.<sup>155</sup> Most of the timberland around the mountain was privately owned by Weyerhaeuser and was being actively logged.<sup>156</sup> At the time, Weyerhaeuser had planted trees to the timberline on the west slope of the mountain.<sup>157</sup> When the volcano erupted, twenty-three square miles of the mountain were blown off laterally, triggering one of the largest recorded landslides in history.<sup>158</sup> Volcanic ash and mud covered 14% of Weyerhaeuser's tree farm holdings at Mount St. Helens, and the company suffered damage that amounted to \$66.7 million.<sup>159</sup> Weyerhaeuser immediately focused on the science of replanting, spending millions of dollars to research and re-seed the mountain.<sup>160</sup>

Weyerhaeuser's efforts were commendable. The company not only spent money cleaning and salvaging timber in the blast zone, Weyerhaeuser spent roughly one million dollars researching how to reforest ash-covered land.<sup>161</sup> Weyerhaeuser then embarked on a "seven-year project in which workers hand-planted 18.4 million seedlings" across approximately 45,500 acres.<sup>162</sup> The meticulous effort paid off; the Douglas fir seedlings had a 90% survival rate, despite being raised from land laden with volcanic debris.<sup>163</sup>

Weyerhaeuser trumpets its reforestation efforts (as might any company that hand-planted acres of tree seedlings), and the corporation

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<sup>155</sup> Alan Taylor, *The Eruption of Mount St. Helens in 1980*, THE ATLANTIC (May 18, 2015), <https://www.theatlantic.com/photo/2015/05/the-eruption-of-mount-st-helens-in-1980/393557/>.

<sup>156</sup> See Eric Wagner, *After Mount St. Helens Erupted, Scientists Fought to Preserve its Devastation*, POPULAR SCI. (May 8, 2020), <https://www.popsci.com/story/science/mount-st-helens-eruption-book/>.

<sup>157</sup> See Michael Upchurch, *'Eruption' places Mount St. Helens in the long perspective: Book review*, OR. LIVE (Mar. 2, 2016), [https://www.oregonlive.com/books/2016/03/steve\\_olsons\\_eruption\\_places\\_m.html](https://www.oregonlive.com/books/2016/03/steve_olsons_eruption_places_m.html).

<sup>158</sup> *The Blast*, WEYERHAEUSER, <https://www.weyerhaeuser.com/company/values/citizenship/mount-st-helens/> (last visited Dec. 4, 2020).

<sup>159</sup> Greg Garrison, *For Weyerhaeuser, a Mammoth Lesson in Reforestation*, DAILY NEWS (May 17, 2010), [https://tdn.com/news/local/for-weyerhaeuser-a-mammoth-lesson-in-reforestation/article\\_cce83814-6215-11df-a0b4-001cc4c002e0.html](https://tdn.com/news/local/for-weyerhaeuser-a-mammoth-lesson-in-reforestation/article_cce83814-6215-11df-a0b4-001cc4c002e0.html).

<sup>160</sup> *Id.*

<sup>161</sup> *Id.*

<sup>162</sup> *Id.*

<sup>163</sup> *Id.*

has justifiably been acknowledged for those efforts.<sup>164</sup> This project emphasizes the difference between sustainability and sustainability-based innovation. The company could have merely funded cleanup efforts and written off its tree farm as a loss. Instead, Weyerhaeuser worked with the Forest Service, the Washington Department of Fish and Game, the Rocky Mountain Elk Foundation, Cowlitz County, and the Washington State Parks and Recreation Commission to do everything from clearing its acreage of downed wood to developing elk forage areas to maintaining the fish population of the lakes on its property.<sup>165</sup>

Of course, re-cultivating its property was necessary if Weyerhaeuser wanted to recover a valuable real estate asset. But Weyerhaeuser did more than just plant trees again. It established a national monument, continued to work with geologists to evaluate the soil, and funded a forestry learning center.<sup>166</sup> These efforts were not just designed to recoup the value of its timberland holdings but also to engineer the replanting and repopulation of the entire mountain.<sup>167</sup>

Perhaps something about crises inspires the Industry to invest in radical innovation. Generally, however, the Industry is considered “traditional” and is not known for its commitment to innovation.<sup>168</sup> However, challenges like climate change, environmentally-conscious consumers and investors, and disruptive events like COVID will require innovation and agility across every segment of the Industry.

#### IV. INVESTMENTS BY SECTOR

To remain competitive, the Industry will have to embrace technological advances and invest in research and development. Demand for paper products will continue to grow, and each sector has unique challenges going forward that require investment in innovation. This part explicates those demands for the timber, pulp, and paper sectors.

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<sup>164</sup> *Forest Management*, WEYERHAEUSER, <https://www.weyerhaeuser.com/company/values/citizenship/mount-st-helens/forest-management/> (last visited Dec. 9, 2020).

<sup>165</sup> *Id.*

<sup>166</sup> Marcelene Edwards, *Harvest from the Ashes*, THE NEWS TRIBUNE (May 4, 2004), <https://www.iatp.org/news/harvest-from-the-ashes-wa>.

<sup>167</sup> *Id.*

<sup>168</sup> Berg & Lingqvist, *supra* note 56.

## A. Timber

With regard to the timber sector, sustainable forestry practices are essential for the continued health of the Industry. Environmentalists define sustainable forestry as

[g]o[ing] beyond satisfying the environmental concerns of governments and consumers by replanting forests, and reducing water consumption and air pollution. It means, in addition, developing new products and market opportunities opened up by growing environmental consumer trends, extending the resource-saving mindset and techniques learned to every area of operations, and understanding and communicating the outcomes of pursuing sustainability to manage regulatory, reputational and operational risks.<sup>169</sup>

In other words, sustainable forestry requires prospective maintenance of natural resources to facilitate long-term objectives.

Timberlands are essential to the paper process, given that wood chips are necessary to produce wood pulp and paper products. To that end, the Industry has embraced managed forest development, also known as silviculture. The silviculture process includes developing the reforestation timetable, handling and protecting seedlings, and then managing the crop by monitoring practices such as pruning, thinning, controlled burning, and harvesting.<sup>170</sup> Beyond the forestry, silviculture encompasses water management, climatology, and the protection of native species.<sup>171</sup> The Finnish government identified four scenarios for operating sustainable forestlands: (1) the global bioeconomy, focusing on climate change and carbon-neutrality; (2) substituting forest bioenergy for fossil fuels; (3) maintaining business solutions for the industry; and (4) creating a self-sufficient society using a renewable resource for biomass food production.<sup>172</sup>

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<sup>169</sup> GÖTZ MARTIN & KARL TOJIC, SUSTAINABILITY: VALUE CREATION IN THE PULP AND PAPER INDUSTRY THROUGH SUSTAINABILITY TRANSFORMATION, MCKINSEY & COMPANY 21–22 (2013), <https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/sustainability-value-creation-in-the-pulp-and-paper-industry>.

<sup>170</sup> AGRICULTURAL MARKETING RESOURCE CENTER, <https://www.agmrc.org/commodities-products/forestry> (last visited Dec. 9, 2020).

<sup>171</sup> *Id.*

<sup>172</sup> Anne Toppinen et al., *The European Pulp and Paper Industry in Transformation to a Bio-economy: A Delphi Study*, 88 FUTURES 1, 1–2 (Apr. 2017).

The Industry is committed to silviculture, but the timber segment still faces many environmental challenges. A study of European companies suggested certain steps to improve environmental practices:

1. Eliminating clearcutting, a logging practice that uniformly cuts down all the trees in a single area, that is still common in South America.<sup>173</sup>
2. Proper management of tree plantations, or the practice of converting a natural forest into a managed tract of land seeded with a single tree species.<sup>174</sup>
3. Eliminating forest mining. Some companies will target a country with low environmental standards and remove large quantities of timber without considering how to reforest the land.<sup>175</sup>
4. Developing new products based on forest products.<sup>176</sup>
5. Improving energy and resource efficiency in developing products.<sup>177</sup>
6. Focusing research and development and forecasting to reduce resource use processes.<sup>178</sup>

Beginning to adopt these steps is an important start to developing sustainable forestry products. Given that most industries are evolving in the digital era, advanced technology to improve precision in forest management will create substantial economic and social value across

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<sup>173</sup> See Sarah Gibbens, *This Map Shows Millions of Acres of Lost Amazon Rainforest*, NAT'L GEOGRAPHIC (Apr. 26, 2019), <https://www.nationalgeographic.com/environment/2019/04/three-million-acres-brazil-rainforest-lost/>.

<sup>174</sup> See SOFIA FARUQI ET AL., THE BUSINESS OF PLANTING TREES: A GROWING INVESTMENT OPPORTUNITY, WORLD RESOURCES INSTITUTE 40–41 (2018), [https://www.nature.org/content/dam/tnc/nature/en/documents/Business\\_of\\_Planting\\_Trees\\_Report.pdf](https://www.nature.org/content/dam/tnc/nature/en/documents/Business_of_Planting_Trees_Report.pdf).

<sup>175</sup> See PETER KNIGHT, WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., A CHANGING FUTURE FOR PAPER 10 (1996), <https://www.wbcsd.org/Sector-Projects/Forest-Solutions-Group/Resources/A-Changing-Future-for-Paper>.

<sup>176</sup> See Toppinen et al., *supra* note 172, at 7, 9.

<sup>177</sup> See Shankar Adhikari & Barbara Ozarska, *Minimizing Environmental Impacts of Timber Products Through the Production Process “From Sawmill to Final Products”*, 7 ENV'T. SYS. RES. 1, 7–9 (2018), <https://link.springer.com/article/10.1186/s40068-018-0109-x>.

<sup>178</sup> See Andrew McEwan et al., *Past, Present and Future of Industrial Plantation Forestry and Implication on Future Timber Harvesting Technology*, 31 J. OF FORESTRY RES. 339, 342 (2020), <https://link.springer.com/article/10.1007/s11676-019-01019-3>; see also Harsh Choudhry & Glen O'Kelly, *Precision Forestry: A Revolution in the Woods*, MCKINSEY & COMPANY (June 25, 2018), <https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/precision-forestry-a-revolution-in-the-woods>.

the globe and improve forest management and wood yields. Though many of these technologies were pioneered in the Europe, adopting them globally will yield cost reductions and improve forest management practices. This, however, will require the Industry to shift its mindset from "broad-brush management prescriptions to a system with digital data capture and planning, granular management prescriptions, and tight operational control."<sup>179</sup>

## B. Pulp

The pulp sector is responsible for record high profits for the entire Industry.<sup>180</sup> Pulp production is the most resource-intensive aspect of the papermaking process, but it is also the most versatile component.<sup>181</sup> The innovation challenge for the pulp sector is twofold: (1) invention and optimization of new products and (2) improvements that render the process more environmentally friendly.<sup>182</sup>

In terms of new product development, pulp producers are focused on new fiber-based products that can replace traditional plastic products.<sup>183</sup> Cellulosic plastics is a new area where many of traditional plastic products are replaced by bio-degradable cellulosic plastics.<sup>184</sup> International Paper's "Thrive" product is an example of how wood products can replace plastic, an ecofriendly alternative that requires less energy to produce, reduces costs, and creates new products using recycled fibers.<sup>185</sup> Plastic packaging materials are produced using

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<sup>179</sup> Harsh Choudhry & Glen O'Kelly, *Precision Forestry: A Revolution in the Woods*, MCKINSEY & CO. (June 25, 2018), <https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/precision-forestry-a-revolution-in-the-woods#>.

<sup>180</sup> See Wood Resources Int'l LLC, *Market Pulp Producers Saw Higher Profits in 2018 as Pulp Prices Jump to Record High Levels, While Production Costs Increased Only Slightly*, PR NEWswire (Aug. 1, 2018, 18:24 ET), <https://www.prnewswire.com/news-releases/market-pulp-producers-saw-higher-profits-in-2018-as-pulp-prices-jump-to-record-high-levels-while-production-costs-increased-only-slightly-300690663.html>.

<sup>181</sup> See Karlstad U., *Environment-Friendly Textiles from Cellulose*, SCI. DAILY (Apr. 27, 2017), <https://www.sciencedaily.com/releases/2017/04/170427110920.htm>.

<sup>182</sup> See Berg Berg & Lingqvist, *supra* note 56.

<sup>183</sup> See Yanqun Su et al., *Prospects for Replacement of Some Plastics in Packaging with Lignocellulose Materials: A Brief Review*, 13 BIORESOURCES 4550, 4552 (2018), [https://bioresources.cnr.ncsu.edu/wp-content/uploads/2018/02/BioRes\\_13\\_2\\_4550\\_Su\\_YLSCZLH\\_Prospects\\_Replace\\_Plastics\\_Lignocellulose\\_Packaging\\_Materials\\_13133.pdf](https://bioresources.cnr.ncsu.edu/wp-content/uploads/2018/02/BioRes_13_2_4550_Su_YLSCZLH_Prospects_Replace_Plastics_Lignocellulose_Packaging_Materials_13133.pdf).

<sup>184</sup> *Id.* at 4550–51.

<sup>185</sup> See *id.* at 4551; see also *THRIVE - Thermoplastic Composite Cellulose Fibers*, EXPERT ENVIRONMENTAL, <https://www.environmental-expert.com/products/thrive-thermoplastic-composite-cellulose-fibers-558292> (last visited Dec. 7, 2020).

petroleum-based polymers.<sup>186</sup> Though they are theoretically recyclable, many countries will not recycle them for economic reasons; for example, China recycles only 20% of the plastic waste it generates.<sup>187</sup> Using wood fibers as a raw resource instead of plastic reduces manufacturing costs and also promotes responsible resource management.<sup>188</sup>

Additionally, new cellulose derivative products from wood as a raw material have become a new sector of innovation. For example, microcrystalline cellulose in the pharmaceutical industry is being used to produce new products for incontinence in the aging population.<sup>189</sup> Wood-based fibers can be feed stock for textile fibers that can replace petroleum chemical-based fibers, like polyesters, but also replace high water-consuming and high fertilizer materials like cotton.<sup>190</sup> Essentially, pulp could be used in making of textile, including face masks.

Despite the constant doomsday predictions of paper's demise, the sector has not given up on itself, continuing to improve its production methods and develop new products. One expert on papermaking machinery explained that "production is energy thirsty, and manufacturers are extremely interested in reducing their energy consumption and environmental impact by using more effective applications. For example, the process uses vast quantities of water, right up to 100 litres per kilogram of paper. A large part of this could be recycled, to reduce the amount of wastewater produced."<sup>191</sup> Energy efficiency monitors, sensors scanning the paper for any defects, and data analytics and optimization are all ways to monitor a paper mill and its product in real-time.<sup>192</sup> Though these developments may not sound like dramatic improvements, they are all ways of controlling manufacturing performance and reducing error.<sup>193</sup>

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<sup>186</sup> Su et al., *supra* note 183, at 4551.

<sup>187</sup> *Id.*

<sup>188</sup> *Id.*

<sup>189</sup> *This Wood-Based Textile Fibre Is Made without Chemical Solvents*, MATERIAL DISTRICTS (Aug. 13, 2018), <https://materialdistrict.com/article/wood-based-textile-fibre/>.

<sup>190</sup> *Id.*

<sup>191</sup> *Paper Innovation Brings New Opportunities*, HOYER, <https://hoyermotors.com/news/paper-innovation-new-opportunities/> (last visited Dec. 7, 2020) (quoting Ewald Harrer).

<sup>192</sup> *Innovation and Energy Savings in the Pulp and Paper Industry*, PULP AND PAPER TECHNOLOGY, <https://www.pulpandpaper-technology.com/articles/innovation-and-energy-savings> (last visited Dec. 7, 2020).

<sup>193</sup> *Id.*

In terms of process optimization, industry efforts have focused on minimizing the environmental impact of the pulp treatment process.<sup>194</sup> Companies have been focusing on effluent water treatment, emission standards, upward pressure on pulpwood prices that may require investment in timberland, and the potential effect of toxicity in the bleaching process on the larger ecosystem.<sup>195</sup>

Additionally, the Industry focuses on improving the health of its pulp products. For example, black liquor and its methanol odor components are rerouted to furnaces.<sup>196</sup> They also skim sodium resonates produced by the black liquor burning process and sell the resonates to refiners who make things like soap products.<sup>197</sup> The furnace smelt runoff, which contains a number of particulates that can be reused, is known as green liquor. Green liquor can be converted into white liquor, which is the main solution used in the pulping process.<sup>198</sup> Even artificial vanilla is a byproduct of the process.<sup>199</sup> The chemical-recovery subprocesses in pulping reduces pulping's environment footprint by reusing almost all of its own discharge.<sup>200</sup> However, the process is still water-intensive, meaning more treatment options for reusing water and reducing wastewater are an important priority.<sup>201</sup>

### C. Paper

For the paper segment, proper forecasting of supply and demand will be critical. Graphic paper is likely to continue declining in demand, requiring a re-imagining of specialty paper products and distribution and supply chains.<sup>202</sup> The paperboard segment, by contrast, is likely to remain a profit driver. However, its continued profitability will require a serious investment in innovation, given the challenges posed by sustainability and regulations, e-Commerce requirements, and potential

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<sup>194</sup> *Zero Liquid Discharge*, SCI. DIRECT (2018), <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/zero-liquid-discharge>.

<sup>195</sup> *Id.*

<sup>196</sup> Armstrong et al., *supra* note 114, at 109.

<sup>197</sup> *Id.*

<sup>198</sup> *Id.* at 106, 109–10.

<sup>199</sup> Julie Crick, *Vanilla is a Forest Industry By-product*, MICH. STATE UNIV. (Jan. 11, 2017), [https://www.canr.msu.edu/news/vanilla\\_is\\_a\\_forest\\_industry\\_by\\_product](https://www.canr.msu.edu/news/vanilla_is_a_forest_industry_by_product).

<sup>200</sup> Armstrong et al., *supra* note 114, at 106, 109–10.

<sup>201</sup> Jeff Gunderson, *Water Treatment in the Pulp and Paper Industry*, WATER TECH. INDUS. WATER MGMT. (May 1, 2012),

<https://www.watertechonline.com/home/article/14171772/water-treatment-in-the-pulp-and-paper-industry>.

<sup>202</sup> See Berg & Lingqvist, *supra* note 56.

competition to its fiber-based products from the lightweight plastics industry.<sup>203</sup>

Critically, COVID has presented a unique challenge for demand forecasting in the consumer goods subsector. Consumer behavior has changed in the last year, and paper manufacturers must be agile enough to adapt to abrupt shifts in consumer behavior. McKinsey developed a six-part plan for manufacturing companies, which involves (1) conducting a granular assessment of each product, customer group, and price tiers; (2) developing sophisticated analytic models to forecast demand; (3) marketing products with an eye on rapidly shifting consumer preferences; (4) optimizing eCommerce channels; (5) aligning pricing and promotional budgets with projected demand; and (6) collaborating with customers to develop a sales strategy.<sup>204</sup> Agility is key to weathering the uncertainty of the pandemic.<sup>205</sup>

For example, toilet paper and towel products surged in the early months of the pandemic, which caused an industrywide shift in its supply chain. On March 12, 2020, toilet paper sales were 734% higher than on the same day the previous year.<sup>206</sup> Sales remained up 71% through May.<sup>207</sup> By March 23, 70% of grocery stores in the United States had run out of toilet paper.<sup>208</sup> This represented a number of challenges for the paper sector. Toilet paper producers had to run at 99.8% capacity in March 2020.<sup>209</sup> Despite increasing paper machine capacity, paper companies could only increase its output by 8%, meaning demand was still outstripping production capacity.<sup>210</sup> Kimberley-Clark executives even held an emergency meeting to determine what types of toilet paper to stop producing in order to focus on more efficient industrial “mega-rolls.”<sup>211</sup> Production of industrial-sized toilet paper rolls, which were normally sold to businesses, were

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<sup>203</sup> *Id.*

<sup>204</sup> Camilo Becdach et al., *Rapidly Forecasting Demand and Adapting Commercial Plans in a Pandemic*, MCKINSEY & CO. (Apr. 21, 2020), <https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/rapidly-forecasting-demand-and-adapting-commercial-plans-in-a-pandemic>.

<sup>205</sup> Jeff Sorensen & Max Blocker, *COVID-19: What it Means for Forest, Paper and Packaging Companies*, PwC (Apr. 9, 2020), <https://www.pwc.com/us/en/library/covid-19/coronavirus-impacts-forest-paper-packaging.html>.

<sup>206</sup> Jen Wiczner, *The Case of the Missing Toilet Paper: How the Coronavirus Exposed U.S. Supply Chain Flaws*, FORTUNE (May 18, 2020, 8:30 AM), <https://fortune.com/2020/05/18/toilet-paper-sales-surge-shortage-coronavirus-pandemic-supply-chain-cpg-panic-buying/>.

<sup>207</sup> *Id.*

<sup>208</sup> *Id.*

<sup>209</sup> *Id.*

<sup>210</sup> *Id.*

<sup>211</sup> *Id.*

produced and marketed to consumers at stores like Trader Joe's.<sup>212</sup> Along with developing new production schedules for the surge in paper demand, analysts also had to adapt their models to account for hoarding of paper products and how that might affect future retail demand.<sup>213</sup>

Paperboard companies had to undergo a process of diversification, adopting processes such as lightweighting.<sup>214</sup> Using paper to replace 3D containers like bottles, cans, and cartons require a different chemical process than what the original design of a typical paperboard product, usually made from recycled mixed paper, considered.<sup>215</sup> Cleaning and separating newspapers, old corrugated boxes, the labels from metal containers from plastic bottles, and metals and plastics from glass, has always been a challenge.<sup>216</sup> Paper companies are generally quite good at repulping recycled paper in order to make a new batch of products.<sup>217</sup> Commercial industries are better than consumers at recycling, meaning paper companies are often working with large quantities of recycled paper.<sup>218</sup> However, when paper is recycled, the ensuing wood pulp requires filtration, cleaning, and de-inking.<sup>219</sup> The challenge facing paper companies is developing a method of utilizing recycled mixed fibers while minimizing the amount of water required to clean them.<sup>220</sup>

The Industry increasingly realizes that sustainability can lower costs by reducing resource input and increasing new product development. This can be done by balancing resource flow, utilizing eco-management to limit fiber losses, connecting as much downstream value back into the upstream value chain as possible, optimizing resource use and making recycling easier, and forecasting resource use to optimize system effectiveness.<sup>221</sup> While the Industry has taken some steps in this direction, sustainability challenges still remain in every segment.

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<sup>212</sup> Travis Durkee, *Discussing the Past, Present, Future of the Tissue & Towel Industry*, FOREST2MARKET (June 24, 2020), <https://www.forest2market.com/blog/discussing-the-past-present-future-of-tissue-towel-production-covid-19-pandemic-0>.

<sup>213</sup> *Id.*

<sup>214</sup> Lightweighting consists of reducing the mass of packaging so that paperboard products are lighter versions of themselves. Peter Berg et al., *The Drive Toward Sustainability in Packaging – Beyond the Quick Wins*, MCKINSEY & CO. (Jan. 30, 2020), <https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/the-drive-toward-sustainability-in-packaging-beyond-the-quick-wins>.

<sup>215</sup> *Glossary*, EPA (Feb. 21, 2016), <https://archive.epa.gov/wastes/conserve/materials/paper/web/html/glossary.html>.

<sup>216</sup> *Id.*

<sup>217</sup> *See id.*

<sup>218</sup> *Id.*

<sup>219</sup> *See id.*

<sup>220</sup> *See id.*

<sup>221</sup> *Design and Management for Circularity – the Case of Paper*, WORLD ECON. FORUM (Jan. 2016), [http://www3.weforum.org/docs/WEF\\_Design\\_Management\\_for\\_Circularity.pdf](http://www3.weforum.org/docs/WEF_Design_Management_for_Circularity.pdf).

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## V. INDUSTRY ROADBLOCKS

Each sector has innovation priorities that are shaped by its role in the production life cycle, and more investment in research and development would make the Industry more efficient and sustainable. Unfortunately, the Industry “appears to be lacking the tools for formally assessing the significance and extent of the changing production and consumption patterns.”<sup>222</sup> The reluctance to make fundamental changes to the paper cycle requires two major adjustments. First, the Industry has generally been reluctant to innovate new products, preferring instead to make incremental changes to its existing processes.<sup>223</sup> However, further investment into internal research and development (“R&D”) will be required to capitalize on new technologies. Second, the road to developing new products or processes must be more agile. The paper industry should be more proactive in creating sustainable value chains and environmentally friendly products.<sup>224</sup> Management should be willing to invest in developing that meet sustainable goals in the long-term, even if they may not affect the company’s bottom line in the short-term.<sup>225</sup> This part explores both requirements in more detail.

First, the Industry is well-positioned to innovate but has low rates of investment in R&D.<sup>226</sup> Innovation in the Industry occurs as a result of the relationships between suppliers, research institutes, consultants, customers, and companies rather than as a result of investment within the Industry alone.<sup>227</sup> The British Paper and Board Industry Federation have identified four necessary types of R&D in the Industry:

- a) continuing support for the enterprise’s activity, b) provision of fundamental research behind existing business, c) development of major new products and processes for existing businesses, and d) provision of support for new business diversification. R&D of type a) is basically oriented to solving specific and well-perceived business problems with a short-term focus whereas types c) and d) are of longer term character and represent higher risk.<sup>228</sup>

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<sup>222</sup> Lauri Hetemäki & Elias Hurmekoski, *Forest Products Markets under Change: Review and Research Implications*, 2 CURRENT FORESTRY REP. 177, 177 (2016).

<sup>223</sup> See Berg & Lingqvist, *supra* note 56.

<sup>224</sup> MARTIN & TOJIC, *supra* note 169, at 26.

<sup>225</sup> *Id.* at 27.

<sup>226</sup> Edward S. Rubin, *Innovation and Climate Change*, in INNOVATION PERSPECTIVES FOR THE 21ST CENTURY 333, 345–46 (BBVA 2010).

<sup>227</sup> ERKKO AUTIO ET AL., INNOVATION ACTIVITIES IN PULP, PAPER, AND PAPER PRODUCTS IN EUROPE 16 (STEP group 1997).

<sup>228</sup> *Id.*

The Industry should focus on unlocking new products. In order to drive long-term growth, companies should adopt long-term solutions alongside short-term value creation. Using both approaches makes economic sense, and it produces social and environmental benefits. As consumers become more sensitive to the ecological impact of the products they use (such as plastic straws), the Industry can position itself as an eco-friendly and sustainable alternative. This, however, requires radical innovation across every sector of the Industry.

A major issue facing the Industry is taking action that focuses on decarbonization and reducing emissions in its production process.<sup>229</sup> Decarbonization requires radical technological innovation in every sector, and transitioning to sustainable low-carbon energy technology requires more commitment to R&D than the Industry is currently providing.<sup>230</sup> Energy efficiency can only occur with the development of new solvents that operate at lower temperatures and retooling the production process to use less water and improve drying technologies.<sup>231</sup> Paper mills will also need to replace fossil fuels with bioenergy and develop drying technologies such as infrared drying or plasma generators that can supply heat to electric boilers without being too carbon-intensive.<sup>232</sup> Additionally, cellulose, lignin, and black liquor have a variety of uses that merit further exploration.<sup>233</sup>

One reason the Industry is unlikely to invest in R&D is that innovation is currently focused on tangible investments like machinery than intangible investments like knowledge management.<sup>234</sup> Namely, the Industry is so capital-intensive and requires so much investment in machinery and equipment that it prioritizes technology expenditures over more dramatic R&D expenditures.<sup>235</sup> Industry leaders consistently outsource knowledge management to suppliers or contractors, indicating that external partners are more capable of innovation than companies are internally.<sup>236</sup> Approaches to innovation and R&D varies by company and country, but the Industry as a whole has lower turnover from new products than other industries, focusing instead on

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<sup>229</sup> See David G. Victor, *Deep Decarbonization: A Realistic Way Forward on Climate Change*, YALE ENVIRONMENT 360 (Jan. 28, 2020), <https://e360.yale.edu/features/deep-decarbonization-a-realistic-way-forward-on-climate-change>.

<sup>230</sup> Rubin, *supra* note 226, at 345–46.

<sup>231</sup> KARIN ERICSSON & LARS J. NILSSON, CLIMATE INNOVATIONS IN THE PAPER INDUSTRY: PROSPECTS FOR DECARBONIZATION 11 (REINVENT 2018).

<sup>232</sup> *Id.* at 12.

<sup>233</sup> *Id.* at 14.

<sup>234</sup> AUTIO, *supra* note 227, at 34.

<sup>235</sup> *Id.*

<sup>236</sup> *Id.* at 35.

incremental changes to existing products.<sup>237</sup> This is in part because the Industry has a fundamental belief that it can innovate without internal R&D by using government laboratories, research undertaken by suppliers of chemicals and technology, research institutes, or universities.<sup>238</sup> Companies will often invest or even patent new designs without making the capital investment in trial actual production.<sup>239</sup> Ironically, this means that some of the most innovative companies in the Industry are not focused on bringing new products to market.<sup>240</sup>

For example, Weyerhaeuser conducted a research project in partnership with the University of Puerto Rico to develop a new generation of diapers.<sup>241</sup> The team was focused on developing a bioluminescent diaper, using enzymes from Puerto Rico's bioluminescent bays as an additive to its cellulosic fluff pulp.<sup>242</sup> The scientists at Weyerhaeuser and the University of Puerto Rico were able to identify marine enzyme components and develop a diaper that would glow when agitated, meaning parents would know when a baby required a diaper change.<sup>243</sup> Weyerhaeuser filed for a patent, but before trial production could begin, Weyerhaeuser converted to a REIT and sold its R&D division to IP.<sup>244</sup> As of the time of this writing the status of the patent is uncertain, and IP has not yet produced the diaper.<sup>245</sup>

The industry sees acquisition of patents and licenses, new product design, and trial production as less important than investment and improvement of current processes or assets. While new products are developed, "R&D in pulp, paper and paper products seem to be more an issue of learning to learn than *discovery*."<sup>246</sup> In fact, a survey of paper companies found that most companies considered patents unimportant with regard to process innovation.<sup>247</sup> They viewed the patent process more as a tool for protecting their lead time advantage over competitors if they decided to pursue production in the future.<sup>248</sup>

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<sup>237</sup> *Id.* at 53–54.

<sup>238</sup> *Id.* at 101.

<sup>239</sup> *Id.* at 109.

<sup>240</sup> *Id.* at 115.

<sup>241</sup> World Intellectual Property Organization No. WO 2016/060850 A1 (issued Apr. 21, 2016), available at <https://patentimages.storage.googleapis.com/14/b3/5a/c4641381d96ab1/WO2016060850A1.pdf>.

<sup>242</sup> *Id.*

<sup>243</sup> *Id.*

<sup>244</sup> *Weyerhaeuser Completes Sale of Cellulose Fibers Pulp Mills to International Paper*, WEYERHAEUSER, (Dec. 1, 2016), <http://investor.weyerhaeuser.com/2016-12-01-Weyerhaeuser-completes-sale-of-Cellulose-Fibers-pulp-mills-to-International-Paper>.

<sup>245</sup> Telephone interview on October 10, 2020 with Brent Peterson.

<sup>246</sup> AUTIO ET AL., *supra* note 227, at 60.

<sup>247</sup> *Id.* at 96.

<sup>248</sup> *Id.*

The second adjustment necessary to reform the paper cycle relates to agility. The Industry has a tendency to suffer from stagnation.<sup>249</sup> The paper production process requires integrating the output of multiple other industries: equipment manufacturers, chemical manufacturers, energy companies, sawmill operators, and software systems.<sup>250</sup> Paper companies are skilled at using the technological expertise of their external partners in process and product innovation.<sup>251</sup> Data indicates that new technologies require efficient internal information channels that coordinate the knowledge held by various divisions of the company and the information channels held by external parties such as research institutes, chemical suppliers, or equipment manufacturers.<sup>252</sup> Information-sharing and coordination is the only competent way to produce the radical technologies required to achieve sustainable energy and resource efficiency.<sup>253</sup> However, the Industry is known for its inability to “search and implement new and innovative opportunities so as to overcome technical barriers.”<sup>254</sup> The Industry is not capitalizing on available knowledge to innovate and develop new products.<sup>255</sup>

For example, the Industry was late at adapting the use of enzyme technology and still has a long way to go adapting technologies that have been adapted with gusto in other industries.<sup>256</sup> The implementation and innovation of enzyme usage has been relatively modest, despite its use bringing significant advantages to the production process.<sup>257</sup> While other industries have fully used the advent of genome sciences to develop novel enzymes to meet their process and product needs, the Industry has yet to take advantage of genome projects to develop new enzymes for biomaterials research. Researchers have

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<sup>249</sup> See Toppinen et al., *supra* note 172, at 4.

<sup>250</sup> See AUTIO ET AL., *supra* note 227, at 15.

<sup>251</sup> See generally *id.* at 33 (discussing the paper industry’s reliance on technology and innovation).

<sup>252</sup> *Id.* at 121.

<sup>253</sup> *Id.*

<sup>254</sup> Braz J. Demuner, Nei Pereira Jr. & Adelaide M.S. Antunes, *Technology Prospecting on Enzymes for the Pulp and Paper Industry*, 6 J. TECH. MGMT. & INNOVATION 148, 149 (2011).

<sup>255</sup> See Bronwyn H. Hall & Dietmar Harhoff, *Recent Research on the Economics of Patents*, 4 ANN. REV. OF ECON. 541, 549 (2012).

<sup>256</sup> See William R. Kenealy & Thomas W. Jeffries, *Enzyme Process for Pulp and Paper: A Review of Recent Developments*, in 845 WOOD DETERIORATION AND PRESERVATION: ADVANCES IN OUR CHANGING WORLD 210, 213 (Barry Goodell et al. eds., 2003).

<sup>257</sup> See Demuner et al., *supra* note 254, at 149.

focused on developing novel uses for enzymes like xylanase, which is already used in the pulp bleaching process.<sup>258</sup>

New enzyme technologies can increase the fiber extracted from recycled paper, optimize fiber properties, remove contaminants in water, reduce the accumulation of residue on papermaking machines, and reduce the chlorine required in the bleaching process.<sup>259</sup> From 1963 to 2010, 602 patents were filed that related to the use of enzymes to improve the pulp and papermaking processes.<sup>260</sup> Nearly 500 of these patents were assigned to private corporations.<sup>261</sup> These enzymes could be a key component of the bleaching process, but novel bleaching technologies are being used in trial production in only twenty mills in America.<sup>262</sup>

Additionally, new paper mill construction is extremely low in North America.<sup>263</sup> This indicates that firms depend on existing historic mills that focus on traditional processes instead of creating new mills that can make new products and innovate new systems. Even if engineers have developed and patented new technology, a company may decline to utilize it in the paper production process and merely hold the patent for the sake of priority.<sup>264</sup> There may be interest in eventually adopting the technology, but the Industry approach of patenting technology appears to be copyrighting potential products before their competitors in case they decide to produce the product in the future.<sup>265</sup>

Ironically, patent protection was how the modern paper industry was created. William and George Russell, who developed a lead-free sulphite digester that would soften wood chips enough to be viable in the papermaking process, patented their work in such a way that they held a monopoly on sulphite technology.<sup>266</sup> William Russell used this monopoly to create the first major pulp and paper conglomerate: the

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<sup>258</sup> William R. Kenealy & Thomas W. Jeffries, *Enzyme Processes for Pulp and Paper: A Review of Recent Developments*, in ACS SYMPOSIUM SERIES, 210, 215 (2003).

<sup>259</sup> *Id.* at 212.

<sup>260</sup> See Demuner et al., *supra* note 254, at 149.

<sup>261</sup> *Id.* at 152.

<sup>262</sup> *Id.* at 155.

<sup>263</sup> *Mapping Pulp Mill Expansion – Risks and Recommendations*, EUR. ENVTL. PAPER NETWORK (Sept. 2015), [https://environmentalpaper.org/wp-content/uploads/2017/09/Mapping\\_Pulp\\_Mill\\_-Expansion.pdf](https://environmentalpaper.org/wp-content/uploads/2017/09/Mapping_Pulp_Mill_-Expansion.pdf).

<sup>264</sup> Demuner et al., *supra* note 254, at 149.

<sup>265</sup> See generally, Christopher A. Harkins, *Fending Off Paper Patents and Patent Trolls: A Novel “Cold Fusion” Defense Because Changing Times Demand It*, 17 ALB. L.J. SCI. & TECH. 407 (2007).

<sup>266</sup> Hannes Toivanen, *Learning and Corporate Strategy: The Dynamic Evolution of the North American Pulp and Paper Industry, 1860-1960*, at 22–33 (Apr. 2004) (unpublished Ph.D. Dissertation, Georgia Institute of Technology).

International Paper Company.<sup>267</sup> IP is still the world’s largest pulp and paper company, commanding 20% of the market in the United States (compared to its nearest competitor, Georgia-Pacific, which holds 13%) and 7.96% of the global market.<sup>268</sup>

The dominance of IP and their corporate strategy demonstrates how control of innovation can affect an organization. Once IP had its patent recognized as valid, it did not install a new papermaking machine for five years.<sup>269</sup> It did not increase output.<sup>270</sup> It merely continued producing newsprint and moved into book page production.<sup>271</sup> It did, however, increase its “daily production capacity of sulphite pulp from 490 tons in 1898 to 858 tons in 1900, and achieved the capacity of about 1,000 tons 1909 where it remained until 1919.”<sup>272</sup> Sulphite was the only technology in which IP invested during the first years of its existence.<sup>273</sup>

The early years of IP illuminate the power of patent rights in defining a company’s innovation strategy — and an entire industry content to focus on existing products. The approach demonstrates a myopia and refusal to evolve. It also demonstrates the cartelization of the paper industry, how once an innovation is accepted as useful, a company will weaponize the patent process to contain it. To reinforce the point, consider the example of the IP-linked Continental Paper Bag Company, which entered the paper bag segment in 1900.<sup>274</sup> In response, Union Bag and Paper Company, which once controlled 90 percent of U.S. paper bag manufacturing, launched a price war and refused to share its technology any longer.<sup>275</sup> The ensuing litigation lasted a decade, going all the way to the Supreme Court.<sup>276</sup> At that point, the parties were arguing over an outdated patent from over a decade ago, simply to determine market dominance.<sup>277</sup>

Patent protection is an extremely important issue for a technology and manufacturing company. The use of patents as proxy for determining market share by withholding technology and stifling

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<sup>267</sup> James Lewis, *January 31, 1898: International Paper Incorporated*, FOREST HIST. SOC’Y (Jan. 31, 2009), <https://foresthistor.org/january-31-1898-international-paper-incorporated/>.

<sup>268</sup> *International Paper’s Competition by Segment and its Market Share*, CSIMARKET, <https://csimarket.com/stocks/competitionSEG2.php?code=IP> (last visited on Dec. 8, 2020).

<sup>269</sup> TOIVANEN, *supra* note 266, at 36.

<sup>270</sup> *Id.*

<sup>271</sup> *Id.*

<sup>272</sup> *Id.*

<sup>273</sup> *Id.* at 37.

<sup>274</sup> *Id.* at 69–70.

<sup>275</sup> *Id.* at 70.

<sup>276</sup> *E. Paper Bag Co. v. Cont’l Paper Bag Co.*, 210 U.S. 405 (1908).

<sup>277</sup> TOIVANEN, *supra* note 266, at 70.

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innovation is counterproductive and can depress innovation. Additionally, institutional attitudes towards individual inventors and innovators can affect how innovative a company is. A recent study examining patents filed at European universities “found wide variation in the extent to which inventions by university researchers were indeed patented by the university rather than industry or the faculty member himself.”<sup>278</sup> Similarly, an employee may assign a patent to the corporation with no knowledge of whether the invention will ever be used, though they may produce it themselves. Once filed, the patent ceases to belong to the employee; it belongs to the employer.<sup>279</sup> As noted, the paper industry has long used the patent system as a way of determining market dominance rather than creating a marketplace of ideas. The coffers of the large conglomerates may be full of patents that could save the earth, but until the Industry emphasizes production, they will never see the light of day.

## VI. CONCLUSION

The pulp, paper, and timber industries play an important role in timber management, resource management, and waste management. The resource-intensive and circular nature of the Industry indicates that future developments will require assessing the extent to which production practices and resource consumption will have to change in order to maintain a sustainable level of input and output. Demand for wood fiber-based products continues to grow, but focus has remained on improving existing processes and products rather than in investing in new product systems. The traditional approach is less viable these days, requiring companies in the Industry to embrace non-traditional innovations.

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<sup>278</sup> Bronwyn H. Hall & Dietmar Harhoff, *Recent Research on the Economics of Patents* 26 (Nat’l Bureau of Econ. Research, Working Paper No. 17773, 2012).

<sup>279</sup> William P. Hovell, *Patent Ownership: An Employer’s Rights to His Employee’s Invention*, 58 NOTRE DAME L. REV. 863, 864 (1983).