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Sustainability Through Open Innovation: Carlsberg and the Green Fiber Bottle

For the Green Fiber Bottle, sustainability is the why, and open innovation is the how.

—FLEMMING BESENBACHER,
CHAIRMAN OF THE CARLSBERG FOUNDATION,
THE CONTROLLING OWNER OF CARLSBERG

In January 2015, Flemming Besenbacher, Chairman of the Carlsberg Foundation,¹ joined executives and regulators from around the globe at the World Economic Forum (WEF) in Davos, Switzerland, in a panel discussion on reducing waste.² In his hand was a prototype for a beer

¹ Besenbacher is also Chairman of the Supervisory Board at Carlsberg A/S and Professor at Aarhus University.

² The other panelists were Peter Bakker, President and CEO, World Business Council for Sustainable Development; David Cheesewright, President and CEO, Walmart International; Tom Gorman, CEO, Brambles; Frans Timmermans,

Faculty Director, Garwood Center for Corporate Innovation and Adjunct Professor Henry W. Chesbrough prepared this case study with Professor of Innovation and Entrepreneurship at the University of Copenhagen Marcel Bogers, and Executive Director of the Berkeley-Haas Center for Responsible Business and Associate Professor at the Copenhagen Business School Robert Strand, and with assistance from Case Writer Elizabeth Whalen, as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

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Robert Strand has conducted scientifically independent research on “Establishing the Global Research Paradigm: Sustainability in a Scandinavian Context” that was previously funded by the Carlsberg Foundation (grant number 2013_01_0515).

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bottle, but not one made of thinner plastic or more durable glass that would represent incremental changes to Carlsberg's existing packaging. Instead, the prototype was made of wood pulp—in essence, a paper bottle. (See **Exhibit 1** for photos of the prototype.) Besenbacher hadn't brought it with him in order to announce that Carlsberg would soon be selling beer in it. In fact, the brewer had only recently partnered with another Danish company to develop the Green Fiber Bottle after three events occurred.

Working with his team between August and December 2014, Simon Boas Hoffmeyer, Director of Sustainability for Carlsberg, conducted a sustainability materiality assessment that included a social listening component to identify topics trending among thought leaders and consumers.

"We found out that bio-materials were a hot topic that were discussed at length," said Boas Hoffmeyer. "But we as a company didn't have any activities to talk about and be part of that conversation in an impactful way."

At the same time, Boas Hoffmeyer was also working with Håkon Langen, Packaging Innovation Director for Carlsberg, and Langen's team to analyze Carlsberg's packaging strategy. They considered that 40 percent of Carlsberg's carbon footprint relates to packaging materials and packaging makes up a significant proportion of product costs.³ They also thought about risk. In the past, policies in some locations banned or taxed bottles and cans, and these policies could be enacted again. The team therefore wanted to proactively add a packaging type to its lineup that was more sustainable and less risky than the existing types. It identified four potential solutions, one of which was a biodegradable beer bottle made from wood pulp.

The idea for a biodegradable bottle was not new to Carlsberg: the brewer had originally explored the option in 2009, but had not progressed beyond the conceptual stage because Carlsberg didn't have the necessary technology. However, Carlsberg was not the only company exploring the idea. ecoXpac, headquartered about forty kilometers north of Carlsberg's Copenhagen brewery, began independently developing the Green Fiber Bottle in 2011. Shortly before the Carlsberg team concluded its packaging strategy analysis in late 2014, ecoXpac contacted Langen about the project. The startup, in partnership with a Danish university and a knowledge institute,⁴ had already advanced the Green Fiber Bottle project from idea stage to early prototype stage. Soon, Carlsberg joined the collaboration.

Boas Hoffmeyer, Langen, and their colleagues then faced the question of how to move the Green Fiber Bottle from the prototype stage to consumers' hands. "We knew that we would not be able to make this bottle happen with just ecoXpac and Carlsberg, but we didn't know exactly whom we needed and which competencies they would have. So, quite fast, we agreed that it would be a really good idea for us to go public with the vision," explained Boas Hoffmeyer. "That's the conundrum when you do something for the first time. You don't know what you don't know. So, we were saying, 'We need help to do this.' [Going public] was the only way we could get the help and partners we didn't know we needed."

³ Carlsberg Group Sustainability Report 2016, <https://carlsberggroup.com/media/10920/2016-sustainability-report.pdf>

⁴ A knowledge institute is an independent not-for-profit organization whose purpose is to spread technical knowledge and methods to increase development. For more, see <https://en.gts-net.dk/about-gts/who-is-gts/>

When Besenbacher showed off the prototype at the WEF, then, he was proclaiming Carlsberg's vision for the future of packaging and seeking additional partners to turn that vision into reality. Over the next three-and-a-half years, the Green Fiber Bottle collaboration would expand and encounter both technical and business hurdles, some of which it has cleared, some of which it still faces.

Carlsberg's Corporate Philosophy and Structure

Taking a long-term view has been part of Carlsberg's purpose and approach to doing business since the company's inception. Above the entry gate to Carlsberg's Copenhagen headquarters hangs a plaque inscribed with the words of founder J.C. Jacobsen that state that the company should, regardless of immediate gain, strive for perfection in making beer. (See **Exhibit 2** for a photo of the plaque.)

J.C. Jacobsen founded Carlsberg in 1847, naming the company after his son Carl. From the early days, Jacobsen prioritized research, innovation, and openness. In 1875, he founded the Carlsberg Laboratory—now called the Carlsberg Research Laboratory (CRL)—to study and improve malting, brewing, and fermenting. In 1883, while working at the lab, professor Emil Christian Hansen isolated a pure yeast culture that would prove essential in improving the consistency of beer production. In 1909, chemist Søren P.L. Sørensen, who headed the laboratory from 1901 to 1938, developed the pH scale. Though both discoveries could have given Carlsberg significant competitive advantage, J.C. Jacobsen made them publicly available, in part to serve the scientific community.⁵ He decreed that “no result of the laboratory’s activity of theoretical or practical significance shall be kept confidential.”

“He was not a scientist himself, but he was absolutely fascinated by scientists” said Anders Bering, Carlsberg’s Vice President for Corporate Affairs. “He lived in this Italian-inspired villa with columns and an atrium, which we still use. He invited Louis Pasteur and other renowned scientists of the time to come and help him do research, help him think about his current problems and some of the challenges for the future.”

To manage the Carlsberg Laboratory and to support Danish scientific research, J.C. Jacobsen established the Carlsberg Foundation in 1876.⁶ When Jacobsen died in 1888, the foundation took over the brewery.⁷ As stipulated by its charter, the foundation has two main objectives: to own a controlling interest in the company and to “support basic scientific research at [an] international level within the natural sciences and humanities for the benefit of society.”⁸

Today, reminders of both the founder and the foundation’s second objective are found throughout the Carlsberg facility: busts of J.C. Jacobsen, Pasteur, and Hansen are part of the building’s façade, and paintings of them line the CRL’s board room. (See **Exhibit 3**.) Scientists at the CRL

⁵ Carlsberg Group, Who We Are, <https://carlsberggroup.com/who-we-are/about-the-carlsberg-group/our-rich-heritage/>

⁶ Ibid.

⁷ The Carlsberg Foundation, <http://www.carlsbergfondet.dk/en/About-the-Foundation/The-Carlsberg-Foundation/The-Carlsberg-Foundation's-Charter>

⁸ The Carlsberg Foundation, <http://www.carlsbergfondet.dk/en/About-the-Foundation/The-Carlsberg-Foundation/The-Carlsberg-Foundation's-History->

continue the legacy in their work: they recently collaborated with those at several other institutions to sequence the genome of barley, the main ingredient in beer.⁹

Even though the Carlsberg Foundation is believed to be the first Danish industrial foundation, foundation ownership is not uncommon today, especially in Europe. Examples of foundation-owned firms include Sweden's Trelleborg, Norway's Kavli, Germany's Robert Bosch, and Switzerland's Rolex.¹⁰ Many foundation-owned companies are private, but some are publicly traded, such as Carlsberg. In fact, foundation-owned firms account for approximately 70 percent of Denmark's stock market capitalization.¹¹ The Carlsberg Foundation maintains control of the brewer by issuing two classes of stock.¹² Class A shares have twenty votes, and Class B shares have two. The foundation owns about 30 percent of all shares but 98 percent of Class A shares, giving it about 76 percent of total votes. (See **Exhibit 4** for an illustration of the Carlsberg Foundation's structure.)

“The main advantage of having this foundation-owned company structure is, to me, that it creates a better possibility for long-term thinking. We are here for the long run, so that structure ensures stability even in volatile times,” said Besenbacher.

The Nordic Way

Companies in Nordic countries,¹³ whether owned by a foundation or not, have demonstrated a tendency to take a highly collaborative approach to management, embracing norms such as consensus-building and cooperation, engagement with critical voices, and high levels of trust. These values extend beyond the firm itself and encourage serving the interests of all stakeholders—including employees, society, and customers—in addition to shareholders.¹⁴ The “Nordic Way” is rooted in embracing the democratic principles that pervade Nordic life. Children in Nordic pre-schools learn of democracy and the practice of engaging with others, voicing opinions, building consensus for a course of action, and cooperating to carry it out—and where these practices are evidenced in Nordic companies.

The concept of the “Nordic cooperative advantage” approach also recognizes that the firm and its stakeholders have common interests and that jointly pursuing those interests creates value. This approach represents a challenge to traditional strategic management more focused on the competitive aspect of business.¹⁵ Nordic firms have a history of closely cooperating with partners to address social problems that affect their stakeholders. For example, the extractive firm Norsk Hydro partnered with Amnesty International to train managers on human rights issues because these issues affected Norsk Hydro’s employees and the communities in which it operates, and because Amnesty International had expertise in the field that Norsk Hydro lacked. Similarly,

⁹ Barley Genome Sequence Cracked, Carlsberg Foundation, April 26, 2017, <http://www.carlsbergfondet.dk/en/News/News-from-the-Foundation/News/Barley-genome-sequence-cracked>

¹⁰ Ibid.

¹¹ Christa Børsting and Steen Thomsen. Foundation ownership, reputation, and labour. *Oxford Review of Economic Policy*, Volume 33, Number 2, 2017, pp. 317-338.

¹² Ibid.

¹³ For the purposes of this case, “Nordic” refers to Denmark, Norway, Sweden, Iceland, and Finland.

¹⁴ Robert Strand and R. Edward Freeman. Scandinavian Cooperative Advantage: The Theory and Practice of Stakeholder Engagement in Scandinavia. *Journal of Business Ethics*, August 7, 2013, DOI 10.1007/s10551-013-1792-1.

¹⁵ The concept of creating shared value, as described by Michael E. Porter and Mark R. Kramer, shares many common elements with this approach. See “Scandinavia can be an inspiration for creating shared value” available at <https://www.ft.com/content/84bbd770-b34d-11e3-b09d-00144feabdc0>.

IKEA developed a longstanding partnership with Save the Children and UNICEF to cooperatively address the risks of child labor in the supply chain. At Carlsberg, the CRL is using the barley genome sequence to develop strains of barley that are resistant to the impacts of climate change; the brewer also recognizes the importance of cooperation to achieving its sustainability goals, which are related to its business strategy (described in the following section).

Nordic countries are perennially atop the major sustainability rankings¹⁶ and Nordic companies are among the leaders in corporate social responsibility rankings, a feat considered a result of their strong stakeholder-engagement practices.¹⁷

Brewing for a Better Today and Tomorrow

When Cees ’t Hart became CEO of Carlsberg in June 2015, the company hired him with the express purpose of improving financial results. As part of the turnaround, he looked to Carlsberg’s history to reinvigorate its purpose, which is now clearly restated in the company strategy as “Brewing for a better today and tomorrow.”

“For the 171 years we’ve existed, we’ve always existed to brew fantastic beers and provide good quality experiences today,” explained Bering. “But we are also here to make sure that we hand over the planet in a better condition tomorrow than we received it.” The Green Fiber Bottle aligns with both aspects of that purpose. “For a lot of consumers, it might meet a need they don’t necessarily know that they have yet because they don’t know that it is possible, but nonetheless it satisfies a consumer need. And it absolutely leaves the planet in better shape than we received it.”

“I believe that many companies are trying really hard to define their purpose,” added ’t Hart. “When I joined Carlsberg, it became clear to me that at Carlsberg, the purpose has always been there. The founders’ mentality permeates the business, and to me, the Green Fiber Bottle is a good example of a project that brings that mentality to life.”

In Carlsberg’s 2016 sustainability report, ’t Hart wrote that sustainability is “central to the Carlsberg Group’s Purpose” and that it is embedded in the company’s new strategy. That strategy, known as SAIL’22, has three pillars: Strengthen the Core, Position for Growth, and Deliver Value for Shareholders, all of which rest on the foundation of Create a Winning Culture. That foundation includes a goal to “contribute to a better society,” which includes sustainability. The report identifies four sustainability priorities: energy and carbon, water, responsible drinking, and health and safety. Within the energy and carbon category, packaging has the largest environmental impact. To reduce that impact, system change is necessary and requires “all relevant players to be involved.”¹⁸

Carlsberg is also working towards eliminating carbon emissions at its breweries and reducing by 30 percent the total value chain emissions of its products by 2030. As part of its Together

¹⁶ E.g., Nordic countries occupy the top four positions of the 2017 Sustainable Development Goal Index available at <http://www.sdgindex.org>.

¹⁷ Robert Strand, R. Edward Freeman, and Kai Hockerts. Corporate Social Responsibility and Sustainability in Scandinavia: An Overview. *Journal of Business Ethics*, May 28, 2014, DOI 10.1007/s10551-014-2224-6.

¹⁸ Carlsberg Group Sustainability Report 2016, <https://carlsberggroup.com/media/10920/2016-sustainability-report.pdf>

Towards Zero sustainability goals,¹⁹ Carlsberg has set a 2022 target to form thirty partnerships to reduce the total CO₂ emissions.²⁰

Besenbacher sees Together Towards Zero as “sustainable business that’s also profitable business. We are not only here to make good for the world; we are also here because this is a very good business plan.” He credits the SAIL ’22 strategy, an efficiency program called Funding the Journey, and Together Towards Zero with reducing Carlsberg’s debt, increasing the return on invested capital, and improving organic growth and profit. Besenbacher summarized the connections among Carlsberg’s ownership structure, strategy, and operations with three Ps. “One is of course profit. We are here to create value for our shareholders, that’s for sure. The next P is purpose. We are a purpose-driven company. And the final P is for planet. I do not believe that you can run a company in the twenty-first century without taking care of the planet.”

Developing the Green Fiber Bottle

When the idea for a bio-based bottle made of wood pulp originated at Carlsberg, more than technical obstacles prevented the brewer from pursuing it. Carlsberg also is not interested in vertically integrating packing into its business. “We produce great beer, and we are great at marketing beer. That’s why it’s very important for us to find the right partners in the value chain to produce the packaging because we don’t look at that as our core competence,” explained Boas Hoffmeyer.

When ecoXpac began pursuing the same idea, before it contacted Carlsberg, it did so as part of a shift in strategy. Originally, ecoXpac had focused on using recycled raw materials to produce molded fiber packaging, such as the trays mobile phones ship in, and employing flexible production lines as a competitive advantage. As it executed on that strategy, though, ecoXpac encountered challenges, including high capital expenditures for production equipment. Founder Jesper Servé eventually decided ecoXpac needed new technology, but that technology didn’t exist. Martin Petersen joined ecoXpac as CEO in 2013, and he proposed shifting from production to developing technology.

Next, ecoXpac assessed molded fiber technologies, which consume large amounts of energy and had not advanced much due to the introduction of plastics in the 1960s and ’70s. By combining its new focus on technology development with a long-term goal to displace plastic packaging, ecoXpac could connect its work with molded fiber to its growing commitment to sustainability. This shift also revealed the need for ecoXpac to be deliberate in its choices. “We learned very early that it’s important to focus on something that people understand and can relate to,” Petersen said. The company could have worked to produce a poultry tray or a bottle. “And it was quite clear early on that a tray for poultry is just not very sexy.”

“It doesn’t drive change,” added Michael Michelsen, ecoXpac’s Global Business Manager.

“A bottle is something you relate to,” Petersen continued. “We had to make the most interesting packaging solution in the industry and use that to lead the whole process of developing a new technology.”

¹⁹ Other goals of Together Towards Zero include zero carbon emissions and water waste at Carlsberg breweries and zero irresponsible drinking and zero lost-time accidents. For more, see <https://carlsberggroup.com/sustainability/our-ambitions/>

²⁰ Carlsberg Group Sustainability Report 2017, <https://carlsberggroup.com/media/22505/carlsberg-group-sustainability-report-2017.pdf>

Partnering with the Technical University of Denmark

In early 2014, ecoXpac contacted Thomas Howard, Associate Professor of Mechanical Engineering at the Technical University of Denmark (Danmarks Tekniske Universitet or DTU), and told him about the Green Fiber Bottle project, which aligned with Howard's research interests. Pursuing the innovation opportunity required knowledge and funding, both of which a relationship with DTU could help ecoXpac secure. The company was planning to apply for funding from the Innovation Fund Denmark (IFD), whose grants require collaboration through their 3:2:1 structure: the IFD provides three parts, the company (in this case, ecoXpac) provides two parts, and a Danish university provides one part.

While IFD was considering the application, Carlsberg responded to ecoXpac that it would like to join the project. The brewer provided access to a significant potential end market that would have been difficult, if not impossible, for ecoXpac to create itself. Carlsberg also has deep knowledge of the technical requirements for bottling its beverages as well as consumer preferences and behaviors. And, it has the experience necessary to test market and gather feedback on an innovation like the Green Fiber Bottle.

Once the fund granted the money, DTU solicited applications for three PhD students to join the mechanical engineering department and contribute to the Green Fiber Bottle project. Those students have conducted lifecycle analyses on iterations of the bottle, studied and improved the manufacturing process, and developed ways to model and test different designs and processes. One student, Mattia Didone, paused his studies for six months to go to work full-time at ecoXpac, where he experimented with ways to reduce energy consumption in the bottle manufacturing process.

Accelerating experimentation has been a key benefit to ecoXpac of its partnership with DTU. "We now have digital models and formulas where we can apply our knowledge and expectations and actually predict the outcomes in advance, which for a mechanical engineering company, is, of course, a major gain," said Michelsen. "That means we have the ability to test earlier and to test ideas that usually we would have to implement, try, and then document the results. We still do that, of course, but now, we have the gift of foresight."

A New Partner with Raw Materials Expertise

Soon after Besenbacher announced the project at the WEF, Magnus Wikström read about it in a trade journal and wanted to learn more. BillerudKorsnäs, the Swedish packaging company where Wikström is CTO, focuses exclusively on fiber-based packaging solutions and materials. Its mission is to challenge conventional packaging for a sustainable future, and its sustainability focus sharpened after the CEO vacationed in Zanzibar and was saddened to see beaches littered with plastic waste. To achieve its mission, BillerudKorsnäs must innovate in order to compete against plastics.

"Plastic packaging grew faster than fiber-based packaging all through the 1990s and 2000s," explained Wikström. "Plastic is such an efficient material. It's easy to print on, and you have a barrier [against gasses and liquids]." Traditional fiber-based packaging for liquids requires a separate barrier layer, such as foil or plastic, which renders the package both unsuitable for recycling in most U.S. municipal systems and unbiodegradable. However, BillerudKorsnäs's CEO isn't the only person concerned about the growing amount of plastic packaging waste and

its environmental impact. Social awareness of the problem is increasing, and some of BillerudKorsnäs's customers have recently expressed interest in alternatives to plastic packaging.

BillerudKorsnäs has a history of partnering with customers, small businesses, and universities, and the company now has a venture arm that invests in startups related to its business lines. As the company learned more about ecoXpac and the Green Fiber Bottle project, two points emerged.

First, BillerudKorsnäs has expertise in raw materials that ecoXpac, Carlsberg, and DTU lacked. To make molded fiber trays, ecoXpac had used primarily recycled fibers as inputs, but to make the Green Fiber Bottle, it needed inputs that would be approved by the U.S. Food and Drug Administration and other similar agencies. These food-grade materials must have traceable inputs, making virgin fibers necessary. Furthermore, different fibers have different properties, such as strength, that are important to producing a bottle capable of withstanding the pressure exerted by carbonation. “It has to withstand pressure that is five times higher than the pressure in a car tire,” elaborated Wikström. “We have to make that amount of strength just with fiber technology.”

Second, ecoXpac needed funds to continue pursuing the bottle project and help finance its portion of the IFD grant. BillerudKorsnäs saw the alignment between the Green Fiber Bottle and its business strategy but recognized the complexities and uncertainties inherent in such a project. Dealing with those would require research and development resources, which BillerudKorsnäs was willing to provide if it would receive a return if the bottle succeeded. Together, these points led to BillerudKorsnäs investing in ecoXpac through its venture arm.

The Role of Open Innovation

The Green Fiber Bottle project is not the first collaborative innovation project Carlsberg has participated in, but the brewer has approached it in a new way. Typically, Carlsberg requires partners to sign non-disclosure and exclusivity agreements in order to protect its first-mover advantage. That wouldn't work for the Green Fiber Bottle, though.

“When you do something that’s a breakthrough innovation like the Green Fiber Bottle, there are so many things that are not established and you do not have knowledge about,” said Boas Hoffmeyer. A few of the unknowns included the composition of fibers that would withstand sufficient pressure, the type of bio-based barrier that would function effectively yet also prove biodegradable, and the design and cap that would satisfy customers. These and other uncertainties rendered Carlsberg’s typical approach impossible, in part because the brewer didn’t know which other organizations would have the necessary knowledge—or if that knowledge even existed yet.

An open approach did raise questions within Carlsberg, which the company resolved by realizing that “if we would not be fully open and transparent, in fact, we would not attract the different companies or institutions that we needed,” said Myriam Shingleton, Vice President, Product Development for Carlsberg. The company also realized it needed to work collaboratively rather than form individual relationships between itself and other organizations. “Because then you enter into a relationship where everyone can benefit, either from an academic point of view, a technical point of view, or with technology they can reuse for other applications.”

One right Carlsberg has secured is that of first refusal. When the bottle is developed, the brewer can decide if it wants to put it on the market itself or pass the opportunity on to another company.

Carlsberg has the right to launch it first, thereby preserving its first-mover advantage and gaining the associated benefits. After a Carlsberg launch, ecoXpac and BillerudKorsnäs may sell the technology behind the bottle to anyone else. Indeed, Carlsberg hopes they do. “It’s also absolutely key that other industries and other companies can benefit from the work we and the partners put into the Green Fiber Bottle because that’s true sustainability—when something can reach the right scale and scope and is not just confined to one company or one industry,” said Boas Hoffmeyer.

For the Green Fiber Bottle, sustainability provided the main motivation for pursuing the goal and open innovation the primary method for achieving it, according to Besenbacher. “We could not have done this alone, that’s absolutely for sure,” he added. “Open innovation is crucial to this project.” In fact, Besenbacher calls open innovation crucial to the entire company, citing as one example its importance in the barley-genome sequencing project.

Building the Business Case

Before Boas Hoffmeyer and Langen could respond to ecoXpac’s request to collaborate, they had to reassure Carlsberg’s management about the project. As they investigated the possibility of the Green Fiber Bottle, they soon realized that they would not be able to put together a typical business case because they lacked information on the majority of components, including volumes, sales markets, production markets, cost of goods sold, and the operating expense of the production line. Management considers all these data points and more when evaluating innovation projects, be they incremental—such as adjusting a recipe or redesigning a bottle but continuing to make it of the same material—or radical, such as the Green Fiber Bottle.

In line with its long-term perspective, Carlsberg recognized the bottle would require more time than an incremental innovation project or the typical process necessary to develop a new product, which usually lasts from six months to one year. Justification to pursue the Green Fiber Bottle therefore came from Carlsberg’s purpose, values, and sustainability goals rather than financial analysis. Furthermore, Carlsberg is always pursuing a portfolio of innovation projects, many of which carry little risk and a few that are relatively more speculative, such as the bottle.

Still, skepticism about the bottle emerged, primarily from within Carlsberg. Concerns related to the different customer experience: the paper-based bottle would not clink the way glass does; it is opaque rather than transparent, so customers cannot see the beer, and it feels different to drink from. Langen responded by reminding his colleagues that the intention is not to replace traditional packaging but rather develop an alternative that is suitable to certain occasions, sales channels, and customers. One potential customer type includes outdoor festivals that have a sustainability-related image or could increase safety with bottles that do not break as glass does.

The early response to Besenbacher’s announcement at the WEF helped bolster the decision to pursue the project. “Retailers were asking whether they could get the bottle into their assortment right away,” Boas Hoffmeyer elaborated. He responded to these inquiries by explaining that the bottle was still in the early stages of development and at least a few years away from a test launch. But, the requests left him feeling hopeful. “When you work within sustainability, having a customer calling you and saying, ‘We would like to buy a product because of its sustainability angle,’ that is an absolutely amazing experience and something I wish I experienced more.”

Customers also expressed positive reactions on social media, which aligned with research Carlsberg had an external agency conduct in 2015. In that, consumers in Denmark, Russia, and the United Kingdom were presented with illustrations and descriptions of the Green Fiber Bottle

but not a prototype. Depending on the market, consumers saw between twenty and thirty packaging ideas. In one market, they ranked the bottle first; in another, they ranked it second, and in the third, consumers ranked it within the top fifth of ideas.

Driving Progress

Once Carlsberg begins pursuing any innovation project, it uses a stage-gate process to evaluate progress. (See **Exhibit 5** for an illustration.) At different stages, a variety of people are involved to determine whether the project will move to the next stage and if the resources necessary to keep it moving are available. The brewer followed essentially the same process for the Green Fiber Bottle, first exploring the potential for the bottle, developing prototypes, conducting technical tests, and assessing the fit with Carlsberg’s brand.

However, because the bottle’s development would take years rather than months and included multiple uncertainties, Carlsberg needed to adjust its normal process for managing the project. One adjustment related to flexibility. Technical progress did not always match expectations. Schedules needed to allow for what might otherwise have been considered delays. When progress was made, even when it was small, it was communicated internally to sustain support. Langen cites ongoing technical achievements, such as improved ability to withstand pressure, as a key factor in keeping the bottle project going. Carlsberg’s long-term perspective added further support, along with the patience necessary to remain flexible.

Internal communication about the project in general helped propel it forward. And, because the Green Fiber Bottle project has required so much collaboration, it has created opportunities for teams within Carlsberg to work together earlier than is typical for other innovation projects.

When appropriate, progress was also communicated externally. For example, in September 2016, Carlsberg unveiled a branded design of the bottle—one more advanced than the original prototype Besenbacher had presented in early 2015—along with images of how the bottle might look on a store shelf next to beer in glass bottles.²¹ These communications helped reinforce Carlsberg’s commitment to the project because, as Shingleton put it, “It shows that the company really means it.” (See **Exhibit 6** for the branded bottle design.)

She also credits executive commitment for driving the project. She and Langen both point to the clear connection between the bottle and Carlsberg’s sustainability strategy, which in turn connects to its business strategy, as providing essential project support. “That helped us to be able to explain the purpose of the project and the benefits,” Shingleton said.

Overcoming Technical Hurdles

Producing a bottle that could withstand the pressure exerted by carbonation was just one of a large number of technical challenges ecoXpac, BillerudKorsnäs, DTU, and Carlsberg faced.

²¹ Carlsberg Unveils New Green Fiber Bottle Design, September 28, 2016,
<https://carlsberggroup.com/newsroom/carlsberg-unveils-new-green-fiber-bottle-design/>

Carlsberg's ultimate goal is for the Green Fiber Bottle to be environmentally and financially competitive with returnable glass bottles, the brewer's most efficient packaging type.²² To meet that goal, the entire value chain for the Green Fiber Bottle needs to be optimized; for example, transportation between the forming plant and the filling plant—and the associated emissions and costs—should be minimized. The bottle production process also needs to fit into Carlsberg's filling process, in which a bottle is filled approximately every six seconds. To date, it takes approximately twelve seconds to form and dry a single Green Fiber Bottle. The current solution to this challenge is to run two forming processes in parallel, producing an average of one bottle every six seconds.

The process to form the bottle must also be sustainable. Even a bio-based, biodegradable bottle—if made using an energy- or resource-intensive process—can compare unfavorably in both its environmental and financial impacts to another packaging type. The typical fiber-based package is produced by first mixing wood fibers with water to form a pulp; the fibers are spread onto a net to create a flat panel, and water between the wood fibers is removed, usually through mechanical pressing. Water within the fibers, about 40 percent of the total water, must be removed through a different process: evaporation. About 90 percent of the overall energy necessary to produce the paper is consumed in this heat-intensive stage.²³ The flat panels are then lined with the appropriate barrier and folded into a cuboid shape.

In the 1970s, a concept that's now known as Impulse Drying Technology (IDT) emerged; it applied a combination of heat and pressure to the pulp, similar to food being cooked in a pressure cooker. With IDT, once the pressure applied to the pulp was released, the superheated water would flash evaporate, resulting in reduced energy consumption compared to traditional drying methods. However, IDT did not fit in well to existing two-dimensional paper-production plants because the equipment is not set up to guide the pressure in a specific direction. Once the pressure is released, the paper blows apart.²⁴

ecoXpac has used the IFD grant money as well as funding from two other Danish subsidy programs to build and adapt from IDT to a three-dimensional process containing the pulp within a mold, the outside part of which is porous. This way, when the pressure is released, the fibers compress into the desired shape while the necessary evaporation takes place. ecoXpac has also developed other technology in fiber molding that makes it possible to produce bottles in three dimensions—rather than first making them in two dimensions and folding them—and to reduce energy consumption.

Many other challenges related to the project's high number of unknowns. For example, before BillerudKorsnäs joined, ecoXpac and DTU were basing decisions about fibers primarily on regulatory requirements because they lacked expertise about which type of wood fiber would be best suited to the bottle's other requirements. “We had to just be pragmatic and do experiments that we could do at the time with the data we had,” explained Howard. “In the end, we had to optimize along the way.”

²² In Denmark and some other European countries, some glass beverage bottles are returnable rather than just recyclable, meaning that empty bottles are collected, washed, and then sent to producers such as Carlsberg to be refilled. Globally, approximately one-third of Carlsberg's products are packaged in returnable glass bottles, one-third are in aluminum cans, one-quarter are in plastic (PET) bottles, and 10 percent in one-way (single-use) glass bottles.

²³ Technology, ecoXpac, <http://www.ecoxpac.dk/technology/>

²⁴ Ibid.

There was also very little research literature available to guide the process. “It was a lot of trial and error,” said Didone. “You start with many ideas and try them out, and then you fail and try again. At some point, you converge towards a solution.”

A second PhD student working on the project, Prateek Saxena, built an experimental workbench where he could do a test run, check the results, and then adjust process parameters to quickly build up a base of data. The third student, Ellen Brilhuis-Meijer, conducted lifecycle assessments that enabled optimizing the design criteria for low carbon emissions.

BillerudKorsnäs engineers have worked on-site at ecoXpac’s offices since 2016. That collaboration is not just useful but necessary because of the close link between the properties of the raw materials and the equipment and process ecoXpac is developing to produce the Green Fiber Bottle.

Beyond the Environment: The Green Fiber Bottle’s Other Benefits

For many employees at Carlsberg, Besenbacher’s announcement at the WEF was the first time they heard about the Green Fiber Bottle, and the majority expressed strong immediate interest in the bottle, according to Bering. “We were taken a bit by surprise by this,” he said. “We got requests of people who want to see it, touch it, even the most skeptical people in the company asking, ‘When can I get this product on the shelves in my market?’ And that is not necessarily the typical reaction you have.”

As Carlsberg has updated its strategy, more than 7,000 employees have attended workshops to understand the company’s goals and renewed purpose. In those workshops, employees also see a short film about how major developments within technology, population growth, and climate change are affecting the planet and businesses. During the workshops, these developments are then related to the Together Towards Zero sustainability goals and innovation projects, including the Green Fiber Bottle.

Employees often wonder about the openness with which Carlsberg has communicated externally about the project and whether that could lead to competitors developing a similar product. “The answer to that question is, ‘Bring it on!’” said Bering. “When we started out on this, there was nobody in this space, so we do not see that as a risk. But the second thing is, if somebody does bring a breakthrough innovation that’s good for climate and good for the consumer experience, then that is a good thing.”

The bottle and the sustainability program that it is a part of have increased employee engagement far beyond Bering’s expectations and more so than any other previous sustainability activities. In fact, in its annual reputation survey, Carlsberg saw its scores on environmental responsibility among employees within the central functions increase by 9.6 points on a one-hundred-point scale from 2016 to 2017, which Bering attributes to, among other things, the Green Fiber Bottle. The positive trend is also evident in the reputation scores among employees in ten key Carlsberg markets and the general public globally; the environmental responsibility scores for these groups increased by 1.7 and 1.9 points, respectively, from 2016 to 2017.

Carlsberg has worked steadily to reduce its water usage and CO₂ emissions and consistently communicates to its employees that the company has become an industry leader in those areas, in the hopes that employees will feel proud of these efforts and tell their families and friends about them. “But I think that those efforts alone may be perceived as too distant and too technical for people,” explained Bering. “Whereas the Green Fiber Bottle allows you to have a conversation at

the dinner table that goes, ‘Did you know that we’re producing a bio-based beer bottle that nobody has done before? Wow!’ And then, if you feel comfortable, you can expand on, ‘This is part of our journey toward carbon neutrality, et cetera.’ It allows you to start that conversation in a completely different way than traditional efficiencies in the supply chain, although these remain crucially important to reaching our targets as well.”

For ecoXpac, the Green Fiber Bottle helps the small firm attract engineers with a personal interest in sustainability and a creative mindset. The company’s sustainability strategy helps it clearly define goals and align the interests of different team members, such as external lifecycle analysis experts, in-house engineers, and production employees.

The DTU students involved in the project have published scientific articles on their work. Didone has conducted research on the process development, optimization, and modeling of molded pulp manufacturing, which is the product category into which the Green Fiber Bottle falls. The technology had not changed since the introduction of the egg carton, and the research carried out on it will enable the diffusion of sustainable packaging. Saxena’s research focuses on the mold tool, its geometry and porous structure to achieve a high-quality yield for the bottle. Brilhuis-Meijer has worked on how conceptual lifecycle assessments can help generate requirements to drive the design process.

Technical and Business Questions Remain

Although the developers of the Green Fiber Bottle have already overcome a number of challenges, they still face many more.

The shelf life of beer bottled in glass is approximately nine to twelve months; beer bottled in plastic lasts approximately three to five months. The current version of the Green Fiber Bottle gives beer a shelf life of about three months. As a result, the bottle is best suited to occasions and events where long shelf life is not required, including the festivals Langen mentioned as well as restaurants. Over time, however, advances may make it possible to extend the shelf life of beer packaged in the bottle.

A bio-based cap is still being developed, so the first version of the Green Fiber Bottle filled with Carlsberg beer will feature a crimped metal cap, similar to the ones on glass bottles.

The barrier on the current version of the bottle is recyclable and bio-based but not fully biodegradable. Carlsberg and its partners have not yet found the technology necessary to make a fully biodegradable barrier that meets Carlsberg’s quality standards, but ecoXpac is working with BillerudKorsnäs to develop such a barrier. “We are introducing a brand-new material base to an existing market,” explained Michelsen. “The existing market does have some opportunities that we could perhaps exploit, but those are not tailored to a paper bottle. They’re tailored to existing market offerings, and it does take a surprising amount of effort, time, money, and competencies to transition from one to the other.”

The lack of information on biodegradability also presents challenges. Many products or materials carry biodegradable certifications, but those certifications do not distinguish the conditions under which the product biodegrades—such as in an industrial facility, in a landfill, or in the ocean. They’re simply certified as biodegradable. And, not much research exists on methods for accelerating biodegradability.

Questions also surround how to scale production. Switching to a biodegradable barrier, once the barrier is developed and chosen, may require adding equipment to the bottle production line. Because the most sustainable approach is to form and fill the bottles in the same place, that could add costs, create the need for more manufacturing space, or both. ecoXpac remains focused on development rather than production, so it is not looking to enter the large-scale packaging production business. The company also wants to generate value from the patents it now has on using IDT to form three-dimensional bottles and trays.

Another scaling challenge relates to how other companies interested in using the Green Fiber Bottle would incorporate it into their operations. “There are no traditional companies making paper bottles,” Wikström said. “So, you cannot just sell this technology to somebody else.” Interested companies might buy bottles that are produced near their bottling plants; they might produce the bottles themselves after either buying a system of machinery and materials or licensing the technology. “It’s also a question of how to manage brand owners that are interested in this,” Wikström added. “What are they willing to pay for? What kind of product are they aiming for? Do they understand that it will be a high-end, niche product as a start but with time, it could be developed into more segments? It is about finding brand owners that understand they have to develop it in order to make it a success.”

The Future: Launch, Test, and Refine

Carlsberg plans to launch the Green Fiber Bottle in 2019 in selected test markets to gauge consumer reaction. The brewer has not yet determined which locations will be the test markets, nor has it finalized the channels where consumers will be able to purchase beer in the bottle, such as in stores, restaurants, or at an event.

ecoXpac will rely on Carlsberg’s expertise in gathering feedback from consumers about the bottle; Petersen and Michelsen have no preconceived notions about what that feedback might say. Carlsberg is also keeping an open mind about consumer response. “This is such a breakthrough that we don’t necessarily know exactly what reactions we will get,” said Bering.

One important question relates to consumers’ willingness to pay a premium for a more sustainable packaging type, which is typically limited. “It’s also how you position it and how you communicate about it,” Shingleton observed. “This will be positioned more as a premium product, and people will understand that it’s new and therefore that it requires a different technology, but definitely they will not pay twice the price of their regular beer.”

Everyone involved in the project sees the test launch as a way to learn; they will then use the feedback from consumers to refine the bottle.

Over time, the bottle could change substantially. “This bottle leaves much, much more room for continuous innovation than any of our other packaging types,” said Boas Hoffmeyer. A key priority is finding a biodegradable barrier, and beyond that, Carlsberg is considering another source for fibers. “The dream vision is for us to actually make the bottle from the straws from the barley that we use to produce our beer. We would take the barley malt and convert that into beer and take the straw and convert that into packaging, and we would have the optimal circular packaging. That vision continues regardless of what version 1.0 of the Green Fiber Bottle looks like when we launch it as a pilot.”

Case Discussion Questions

1. Consider the strategies of each entity involved in developing the Green Fiber Bottle. How did these strategies make this project possible?
2. What advantages did Carlsberg's foundation ownership structure and purpose-driven approach give the brewer in its pursuit of the Green Fiber Bottle?
3. If Carlsberg had an ownership structure more typical of other companies (in which a majority ownership is not held in perpetuity by an industrial foundation like the Carlsberg Foundation) and did not have the purpose-driven approach, what challenges might Carlsberg have faced when pursuing the project?
4. How does the Green Fiber Bottle create value for each of the involved organizations?
5. The Green Fiber Bottle will be a new packaging type for an existing product, yet Carlsberg is planning to position it as a premium product.
 - a. What challenges does this situation present?
 - b. What specific ways can Carlsberg communicate to consumers that the beer bottled in the Green Fiber Bottle is worth a premium price?
6. What should the organizations involved in the Green Fiber Bottle project do if consumer reaction is negative?
7. One motivator for the Green Fiber Bottle project is disrupting plastic packaging, in part because of the environmental problems it causes. Will private-sector projects like the Green Fiber Bottle be sufficient to address this problem? If not, what other entities need to act, and how?

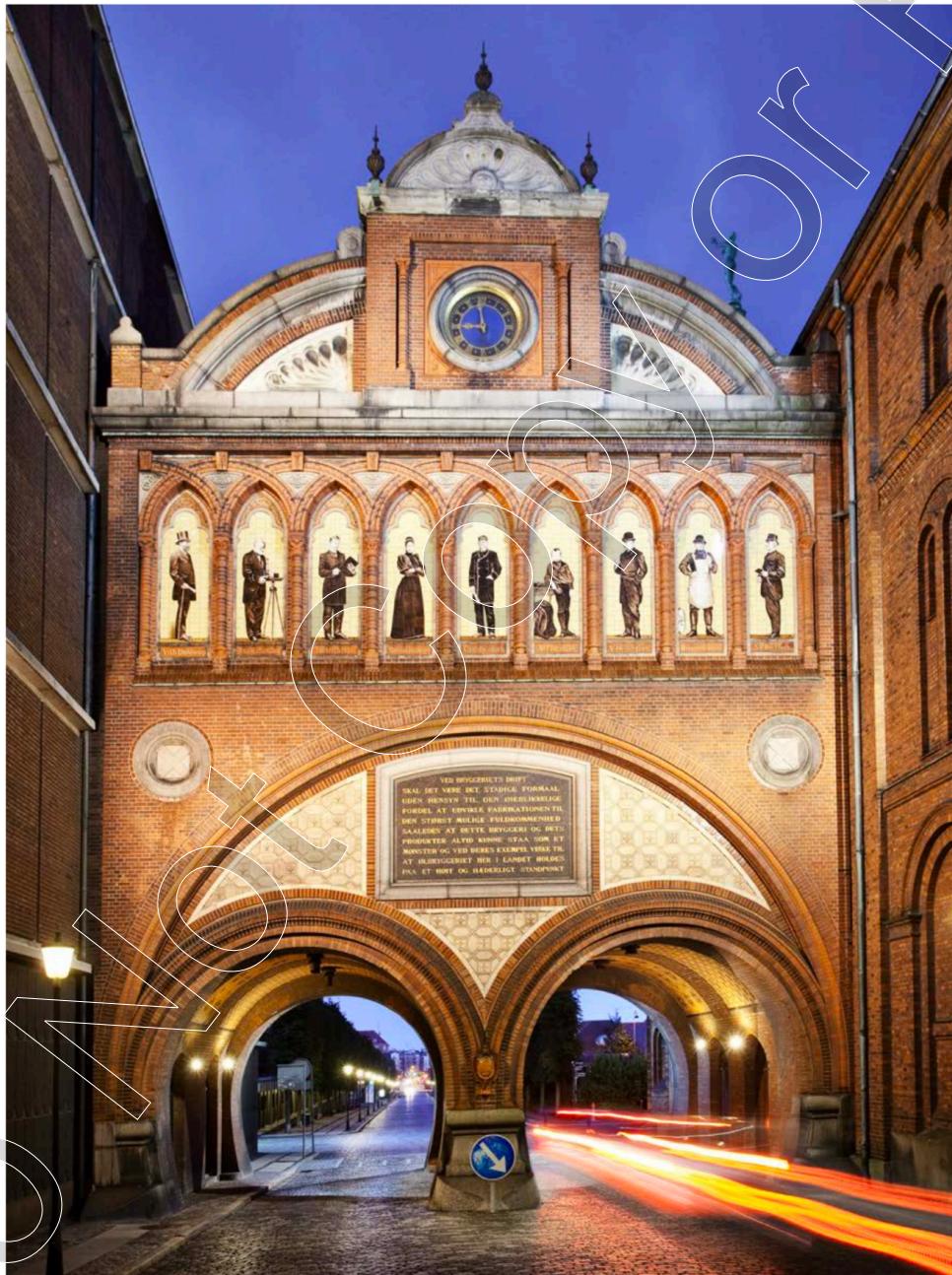
Exhibit 1 Flemming Besenbacher and the Green Fiber Bottle prototype at the World Economic Forum



Source: World Economic Forum / Benedikt von Loebell.

Exhibit 2 The Dipylon Gate, the entrance to the Carlsberg Group's headquarters in Copenhagen

English translation of the plaque's inscription: "In working the brewery it should be a constant purpose, regardless of immediate gain, to develop the art of making beer to the greatest possible degree of perfection so that this brewery as well as its products may ever stand out as a model and, through their example, assist in keeping beer brewing in this country at a high and honorable level."



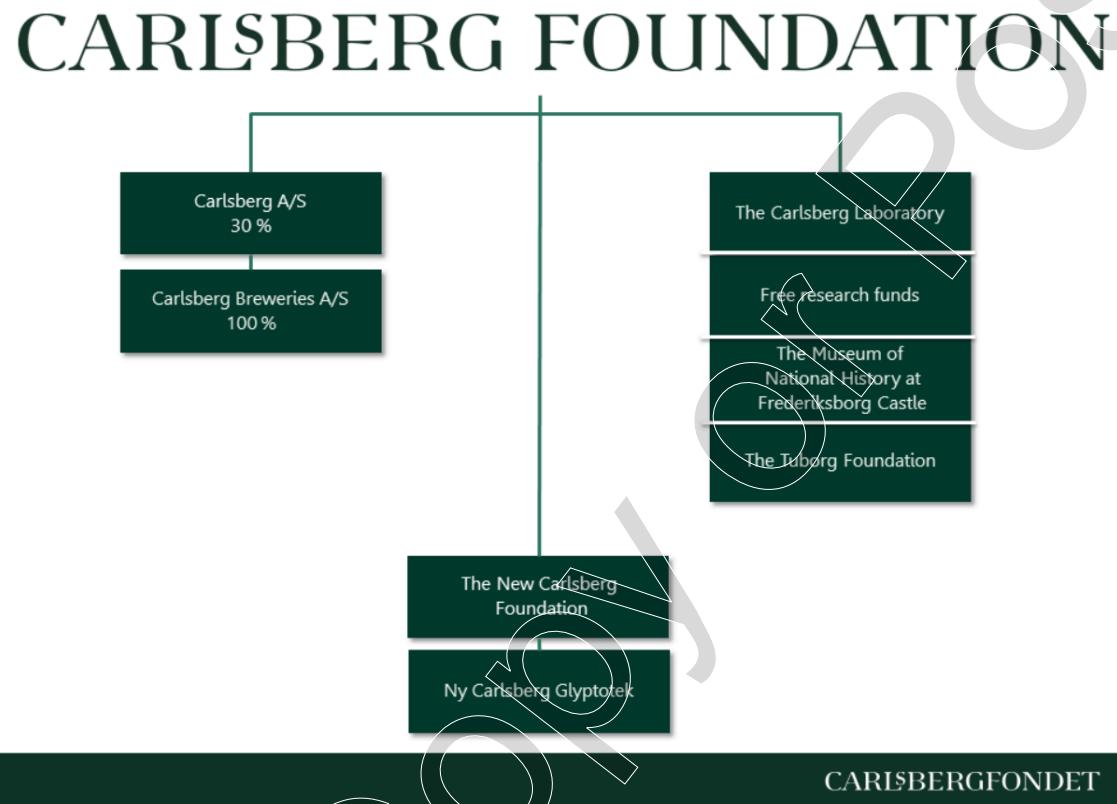
Source: Carlsberg.

Exhibit 3 Portrait of scientists from the Carlsberg Research Laboratory's board room

English translation of the inscription: “No result of the Institute’s actions that has theoretical or practical importance may be kept secret.”



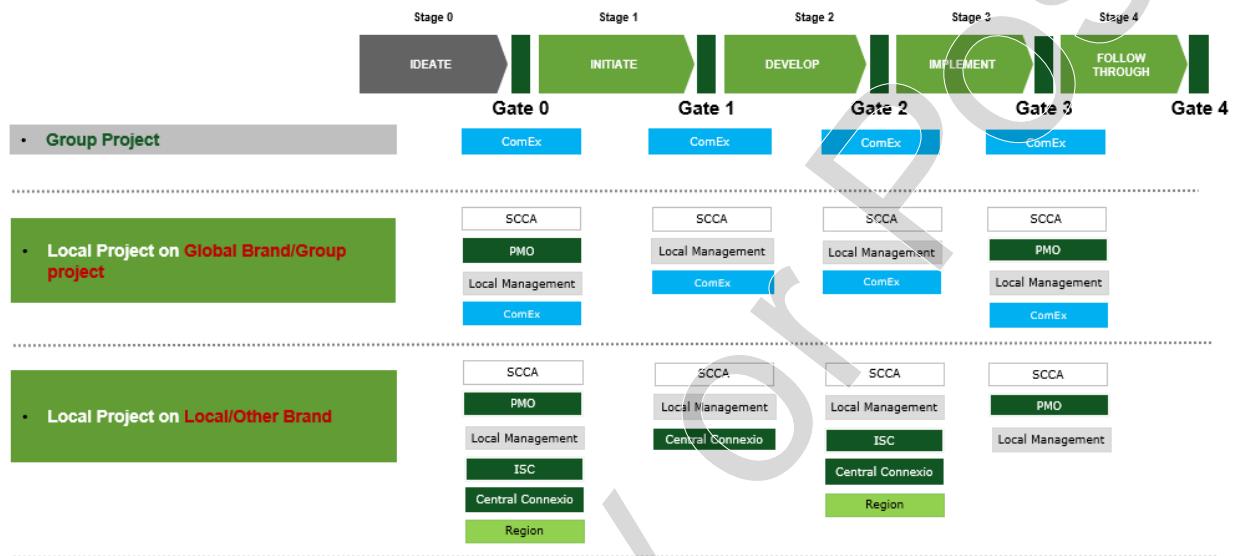
Source: Carlsberg.

Exhibit 4 The Carlsberg Foundation structure

Source: Carlsberg.

<http://www.carlsbergfondet.dk/en/Om%20fondet/Carlsbergfondet/Carlsbergfamilien/Organisationsdiagram>

Exhibit 5 Carlsberg's Stage-Gate Innovation Management



Key:

ComEx: Commercial executive committee, a cross-functional group managing global brands and strategic innovation projects

SCCA: Supply Chain Complexity Assessment

PMO: Project Management Office

ISC: Integrated Supply Chain function

Central Connexio: Centrally led network of local technical packaging and brewing experts

Region: Carlsberg has three regions: Western Europe, Eastern Europe, and Asia. Each has an administrative commercial function.

Source: Carlsberg.

Exhibit 6 The branded design of the Green Fiber Bottle



Source: Carlsberg.