

Combining the De-alcoholization of Beer and the Alcohol Fortification of Kombucha

(Technical Project)

Analyzing the Transformation of Cultural Logics as American Brewing Companies Expand
Operations

(STS Project)

A Thesis Prospectus

In STS 4500

Presented to

The Faculty of the

School of Engineering and Applied Science

University of Virginia

In partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Chemical Engineering

By

Patrick Salvanera

27 October 2023

Technical Team Members: Christopher Griffis, Sara Reisz, Gloria Zhao

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

ADVISORS

MC Forelle, Department of Engineering and Society

Eric Anderson, Department of Chemical Engineering

Introduction

The American brewing industry is gargantuan, with beer companies employing over 200,000 people and domestically producing over 100 million barrels of beer each year (Brewbound, 2019; Brewers Association, 2023). In an industry so vast, there have been several studies done discussing the social inequalities that exist in both the producers and the consumers. For instance, researchers studied internet forums in the craft beer world and found that by constantly assigning genders to drinks, users were reinforcing harmful gender norms and creating a hierarchical environment that placed men at the top, equating them with having supposedly more knowledgeable and sophisticated tastes (Chapman et al., 2018).

My thesis portfolio aims to address the systems that reinforce social inequalities and the emerging markets that have the potential to exclude those systems, or at least mitigate their presence to a significant extent. The technical project will focus on creating two products that are becoming increasingly prevalent in the beverage space: non-alcoholic (NA) beer and hard kombucha (Smith, 2022; Maximize Market Research, 2023). By combining the processes of de-alcoholizing beer and fortifying kombucha, we will hopefully create a single, new, and commercially viable process that will cater to multiple demographics.

The STS project will focus on the cultural logics that exist in the brewing industry, and how they may impact systems of social inequalities. Through this project, I hope to create a foundation that will lead to more genuinely equitable practices by employers in the brewing industry. Due to the novelty of the NA beer and hard kombucha markets, the findings in my STS project may be useful for the companies who spearhead these markets in implementing cultural logics and hiring practices that create a genuinely equitable industry.

Technical Project

The non-alcoholic beer and hard kombucha industries are two rapidly growing markets. Non-alcoholic beer sales have “climbed ninety percent over the last decade” (Smith, 2022). Additionally, over the next seven years, hard kombucha sales are expected to have a compound annual growth rate of 23.76% (Maximize Market Research, 2023). Current target demographics for non-alcoholic beer include those who want to reduce alcohol intake, those who abstain from alcohol for religious or health reasons, and those who enjoy the ritual of drinking but do not want to experience the effects of alcohol. Additionally, many people are leaning towards non-alcoholic beer due to it containing fewer calories and sugars than alcoholic beer (Maximize Market Research, 2022) and having been shown to help “maintain blood electrolyte homeostasis during exercise (Castro-Sepulveda et al., 2016).

Despite the market growth and demonstrated interest, however, non-alcoholic drinks are currently not prevalent or available mainstream due to it being an expensive process to make (Salanta et al., 2020). While the process technology has been researched, it has not been implemented yet on a widespread, commercial scale because of its lack in profitability.

To address the potentially lucrative non-alcoholic beverage market, multiple dealcoholization methods have been developed in recent years. Two such methods include thermal and membrane separation. Thermal separation involves vacuum distillation to separate the alcohol from the beverage based on differences in their volatilities, whereas membrane separation, most notably reverse osmosis (RO) membrane filtration, involves pushing a beverage across a semipermeable membrane and separating water and ethanol from the rest of the beverage based on particle size selectivity (Jackowski & Trusek, 2018). However, there is a fundamental problem with these methods concerning their large-scale implementation feasibility.

These dealcoholization methods, while valid processes, are too expensive by themselves to be implemented on a commercial scale. Companies currently trying to produce non-alcoholic drinks view the process as a standalone entity by making them exclusively, therefore failing to consider the profitability of catering to two separate audiences: people who want alcoholic drinks and people who want non-alcoholic drinks. If these beverage companies continue to take this current approach, they will also continue to fail at making profitable non-alcoholic beverages and miss out on catering to two potentially profitable demographics: those interested in novel alcoholic and non-alcoholic beverages.

The aim of this technical project is to avoid this scale-up feasibility obstacle by designing an industrial-scale manufacturing process that produces two beverages — a non-alcoholic beer and an alcoholic kombucha — to make this process commercially profitable. The first part of the process will involve brewing beer and converting it to non-alcoholic beer via reverse osmosis. The creation of beer will follow standard brewing procedures, in which malt kernels are milled, water is added, enzymes are activated via heat, and yeast is added to convert sugars to ethanol during fermentation (Grover et al., 2022). Then, reverse osmosis membrane filtration will separate water and ethanol from the beverage, after which additional separation will isolate the ethanol from the water and water will be re-supplied to the beer. The second part of the process will involve fermenting kombucha and injecting it with the removed ethanol from the beer. The fermentation of kombucha involves steeping tea, adding sugar and symbiotic culture of bacteria and yeast (SCOBY), removing SCOBY after fermentation, and carbonation (Wang et al., 2022), after which ethanol will be infused in the final beverage.

Initial design data for the manufacturing process will be obtained from research articles pertaining to the non-alcoholic beer and kombucha processes. We will use computational tools,

such as Aspen Plus and Matlab, to generate, test, and monitor unit operation for process optimization. We will be reaching out to Geoffrey Geise, associate professor at the University of Virginia who specializes in membrane research, to inform our membrane selection, assist in design specifications, and operate modeling software to design and perform analysis on the filtration membrane system. Lastly, we will be using hand calculations and Microsoft Excel to solve material balances and compare results with simulation software. Additionally, we will reach out to and visit Three Notch'd, a local craft brewing company, and conduct an interview to gain insights into commercial brewing design.

An iterative process will be used to optimize our process: each iteration of the system design will provide design data for the next. To demonstrate the value of the system, we will perform a thorough economic analysis on our end design to determine if our process is commercially viable. The final product of this project will be a process report outlining the material and energy balances, equipment design, and economic, health, and safety implications of the proposed plant, produced by the team in CHE 4476 in spring of 2024.

STS Project

In the American brewing industry, there are systems in place that reinforce social inequalities in the brewing industry. Even as companies try to move away from hiring practices that historically rely on gender, race, and class, a study has found that the cultural logics at play have “reinforced the dominant position of white, middle-class men in [the brewing] industry while simultaneously marginalizing the experiences of women and people of color” (Wilson, 2022). Cultural logic is a term that describes the process of people using stereotypes and other precedents to hypothesize other’s motivations and intentions (Enfield, 2000). Wilson coins the primary cultural logic of the study as “pure passion”, referring to the increasingly common idea

of finding a passion for work, which is used both by workers making career choices and employers making hiring decisions.

In this project, I plan to explore the relationship between technological politics and cultural logics and how they exist in the brewing industry. The theory of technological politics describes the effects that technologies have on power and social relations (Winner, 1980). This theory's relevance is significant, as the brewing industry prefers people with a general technological aptitude and a knowledge of relevant brewing machinery and software (Solaris Biotech, n.d.). Exploring how these technological politics intersect with "pure passion", and other prominent cultural logics that I may find through this project, will help create a more detailed and multi-faceted understanding of the systems of inequality that are at play in the industry.

To help with the desire to achieve this detailed and multi-faceted understanding, I will also employ the concept of intersectionality, which "describes the ways in which systems of inequality based on gender, race, ethnicity... and other forms of discrimination intersect to create unique dynamics and effects" (Center for Intersectional Justice, n.d.). Employing intersectionality is a fruitful cause as it prioritizes the recognition of how one's inherently complex identity shapes and is shaped by their environment. This will allow me to delve deeper into the relationships that exist between the individual workers and the systems of inequality.

Research Question and Methods

To investigate this process, I plan to ask the question: how do the cultural logics of American brewing companies change as they expand from a small-scale craft brewery to a larger scale brewing company? By developing an answer to this question, I will be able to identify and

analyze the forces at play in the sociocultural aspect of the brewing industry, which directly employs hundreds of thousands of people and caters to millions more in the United States.

To start off the investigation, I will conduct a literature review, researching the histories of nationwide beverage companies – during and after the Prohibition era – and the changes they went through as they expanded their operations. I also plan to research these companies' public images, noting if there has been a historic relationship between public perception and the cultural logics of a company. To sufficiently support my findings from the literature review, I will conduct a series of nine interviews with brewing companies that cover the industry's range in regard to size. Companies such as Charlottesville-based Three Notch'd, San Diego-based Pizza Port, and the Elkton, VA-based Molson Coors plant are likely candidates for me to interview. I also plan to include interviews with kombucha companies such as Blue Ridge Bucha. In these interviews, I will ask questions to learn more about the companies' history in hiring practices, especially concerning women and people of color. I also hope to learn more about the technical aspect; as they expanded or start to expand, I want to learn what their priorities are regarding economics and engineering. The final thing I hope to gain from these interviews is knowledge about each company's work culture; I plan to use this cultural information to bolster any conclusions that I make on the existing social systems of ineq/uality.

Conclusion

In my technical project, I will be designing a process that combines the de-alcoholization of beer and the fortification of kombucha to cater to growing markets. The findings from this project may lead to breakthroughs in more niche beverage markets and give people more options for drinks that they will enjoy.

By combining the theories of technological politics and cultural logics while gathering information through a thorough series of interviews, I will identify the technologies associated with scaling up brewing operations and analyze the extent to which they reinforce existing social inequalities in the brewing industry. The findings from this research may help produce positive change, starting with human resource and public relations departments. The end goal would ideally be a safer and more equitable workplace for everyone in the brewing industry.

Word count: 1775

Works Cited

- Brewbound. (2019, May 21). *Study: US beer industry supports more than 2 million jobs*.
<https://www.brewbound.com/news/study-us-beer-industry-supports-more-than-2-million-jobs>
- Castro-Sepulveda, M., Johannsen, N., Astudillo, S., Jorquera, C., Álvarez, C., Zbinden-Foncea, H., & Ramírez-Campillo, R. (2016). Effects of Beer, Non-Alcoholic Beer and Water Consumption before Exercise on Fluid and Electrolyte Homeostasis in Athletes. *Nutrients*, 8(6), 345. <https://doi.org/10.3390/nu8060345>
- Center for Intersectional Justice. (n.d.). What is intersectionality.
<https://www.intersectionaljustice.org/what-is-intersectionality>
- Chapman, N. G., Nanney, M., Slade Lellock, J., & Mikles-Schluterman, J. (2018). Bottling gender: accomplishing gender through craft beer consumption. *Food, Culture & Society*, 21(3), 296–313. <https://doi.org/10.1080/15528014.2018.1451038>
- Enfield, N. J. (2000). The theory of cultural logic: How individuals combine social intelligence with semiotics to create and maintain cultural meaning. *Cultural Dynamics*, 12(1), 35–64.
<https://doi.org/10.1177/092137400001200102>
- Grover, N., Nehra, M., & Sk, G. (2022). Non Alcoholic Beers: Review and Methods. *Madridge Journal of Food Technology*, 7(1), 200–206. <https://doi.org/10.18689/mjft-1000130>
- Jackowski, M., & Trusek, A. (2018). Non-alcoholic Beer Production – an Overview. *Polish Journal of Chemical Technology*, 20(4), 32–38. <https://doi.org/10.2478/pjct-2018-0051>
- Maximize Market Research. (2022). *Hard Kombucha Market: The increasing popularity of hard kombucha among health-conscious consumers is a significant factor driving the growth of the market*. Maximize Market Research. <https://www.maximizemarketresearch.com/m>

arket-report/hard-kombucha-market/184929/

Maximize Market Research. (2023, April 18). *Hard Kombucha Market Size to hit USD 181.88*

Mn by 2029 at a CAGR of 23.76 percent – Says Maximize Market Research.

GlobeNewswire. <https://www.globenewswire.com/news-release/2023/04/18/2648819/0/en/Hard-kombucha-Market-size-to-hit-USD-181-88-Mn-by-2029-at-a-CAGR-of-23-76-percent-Says-Maximize-Market-Research.html>

National beer sales & production data. (n.d.). *Brewers Association*. Retrieved October 26, 2023, from <https://www.brewersassociation.org/statistics-and-data/national-beer-stats/>

Salanta, L.C., Coldea, T.E., Ignat, M.V., Pop, C.R., Tofana, M., Mudura, E., Borsa, A.,

Pasqualone, A., & Zhao, H. (2020). Non-Alcoholic and Craft Beer Production and Challenges. *Processes*, 8(11), 1382. <https://doi.org/10.3390/pr8111382>

Smith, S. (2022, July 28). *Trends Revealed: The Non-Alcoholic Beer Market Is Bubbling Up.*

Hubspot. <https://blog.hubspot.com/the-hustle/the-non-alcoholic-beer-market-is-bubbling-up>

Solaris Biotech USA. (n.d.). *The Challenges of Scaling Up and Selecting the Right Pilot Scale*

Fermenter. <https://solarisbiotechusa.com/scaling-up-pilot-plant#:~:text=Pilot%20 fermentations%20require%20an%20intimate,the%20challenges%20of%20scaling%20up>.

Wang, B., Rutherford-Markwick, K., Zhang, X.-X., & Mutukumira, A. N. (2022). Kombucha:

Production and Microbiological Research. *Foods*, 11(21), 3456. <https://doi.org/10.3390/foods11213456>

Wilson, E. R. (2022). Privileging Passion: How the Cultural Logic of Work Perpetuates Social

Inequality in the Craft Beer Industry. *Socius: Sociological Research for a Dynamic World*, 8. <https://doi.org/10.1177/23780231221121064>

Winner, L. (1980). Do Artifacts Have Politics? *Daedalus*, 109(1), 130.