Building Autonomous Vehicles for Optimal Meal Timing

(Technical Paper)

Social Influences on the College Diet and effects on Academic Performance

(STS Paper)

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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

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Healthy diet: a diet balanced in its calorie intake and expenditure, involving mostly unsaturated fats, and limited fat, sugar, and salt intake (World Health Organization, 2019). As high level and simple as this outline may be perceived, diet is an often overlooked aspect of health unless deliberate effort is made towards it. This is especially true for busier groups who do not have the time or resources to plan meals, leading into the target group for research: college students. Even when viewing the broader scope of health, Dong Wang found university students to be "minimally engaged in health-promoting behaviors and exhibit behavioral health risks, such as tobacco use, alcohol and substance abuse, and improper diet and physical activities" (Wang, 2013). Considering that undernourishment leads to "decreased attendance, attention, and academic performance" (Florence, 2008), a subpar diet is less than optimal for the high performance requirements of a college student.

While every component of health has significant consequences to the performance of not just college students but all groups, diet is the most easily improvable component in a college lifestyle. Whether it is the diet itself or food timing, these can be changed with simple decisions that have less of a consequence on other aspects of a college students' life. This does not intend to disregard the impact of other components of health including sleep and physical activity, however diet changes are the easiest to integrate into busy college lives.

As such, the goal of the technical project will be designing and developing an autonomous food delivery robot promoting healthy meal times. The first iteration of the robot will likely reside in a controlled environment where it will deliver to a smaller area, such as a waiter in a restaurant, to reduce the environment variability. Given the time constraints for the project, this will be a more reasonable goal and will help towards the eventual goal of campus

food delivery. Not to mention, the current project will still promote research into healthy meal timings and other health goals for college students.

The analysis within this research paper will enact Social Construction of Technology (SCOT) in order to explain the social and technical factors influencing the underwhelming focus on college diet and subsequent academic performance. The SCOT intends to analyze and provide better insight into the issue by delving into the major stakeholders that affect it, including a look into what they do and their perspective on the issue (Interpretive Flexibility). The purpose of this analysis is to better understand the college food chain, enabling future research, to ultimately suggest a better system for college food systems in the STS Research Paper.

Autonomous Delivery: Delivering food in a timely manner

Robotics has evolved to have a wide array of applications, providing solutions to a variety of societal issues and challenges. Following this trend, the current project aims to apply robotics, including components of software, hardware, and electrical engineering, to the field of autonomous delivery. The culminating target of this technical project is designing and developing an autonomous vehicle tailored to deliver small objects, possibly food items, within a confined and stable environment. The target audience for the initial delivery robots are restaurants or small office spaces, acting as a form of waiter between the source and destination of food. The final form, extending beyond the scope of this project, would cater towards college students in a campus setting.

Under the guidance of Professor Adam Barnes, a team of six computer engineering students, Pranav Ramkumar, Ky Nguyen, along with four other potential classmates, will spend a semester building a robust autonomous vehicle capable of delivering small food items and objects around Thornton A wing. The vehicle will autonomously navigate the hall, have the

ability to hold objects, recognize obstacles, and be user-friendly. Our design incorporates a multifaceted set of functionalities, each designed to meet the unique requirements of our intended users. Central to its capabilities is autonomous navigation, enabling the vehicle to move around the environment without direct human control. This autonomy extends to obstacle avoidance, a crucial feature that ensures the vehicle avoids collisions and traffic. To achieve this, each team member will contribute to developing the Printed Circuit Board (PCB) that connects the given microcontroller to the remote controlled (RC) car's circuit board. The PCB will act as a regulator, allowing the microcontroller to function properly when integrated with the rest of the RC car. Additionally, team members will develop software that provides instructions to the microcontroller on how to integrate all the sub-parts into a cohesive system, including the car's main circuit board, cameras, power supplies, sensors, and user interface screen. Team members will also be responsible for training the machine learning model from scratch, which will send signals to the microcontroller to control the vehicle and process signals from the three surrounding cameras attached to the car. The data for this learning model will be extracted solely from the vehicle's 3 cameras. Team members will clean and feed the data to the machine learning model. Our vehicle's design focuses on robustness, ensuring its ability to securely transport small objects and withstand moderate collisions. Team members will research durable, affordable, and functional chassis options for the design. In terms of the user interface, user-friendliness is a priority. A distinguishing feature of our design is its voice-controlled interface, allowing users to fully control and activate the car using voice commands. To achieve this, team members will develop a second machine learning model for voice activation, capable of recognizing a specific keyword. Team members will create comprehensive user interface software to communicate the car's functionality through a liquid-crystal display (LCD) screen. Lastly, members will develop a

cohesive testing plan to test each sub-part of the vehicle and ensure that it functions properly and meets safety regulations.

A Sociotechnical Analysis of Influences and Perspectives that Drive College Food Consumption

The food industry and the process by which food travels from producer to consumer involve many complex processes. On top of the personal choices made by the consumer, the availability of choices, availability to the local distributors, production choices, and government regulation all act as a plethora of factors in this system determining what food reaches the consumer. Expectedly, these factors will not all be conducive to healthy dieting, and in this broad of a context, there exist a multitude of reasons for failures in the chain and many ways to tackle the issue.

In the context of a college environment, the major stakeholders to the college diet can be narrowed down to 4 components: Dining Hall, College Food Providers, College Administration, and Students. Each stakeholder varies in impact on a case by case basis but when conjoined define the diet of college students.

Behavioral Economics of Dining Halls

Considering that the dining hall is the closest to the student in the chain of food production, it has many obvious links to diet. Cynthia Radnitz, a reporter for the Cambridge University Press, and her colleagues, derived suggestive conclusions from a food study performed on first year college students. The study involved varying the time in which the food was delivered. Specifically, healthy foods were provided immediately upon request while unhealthier options involved wait times before provision. This led to the findings: "94% of food choices were in the OD condition optimal" (Radnitz, 2018). The OD condition references the

group in the study that was presented with a 15 minute wait time if unhealthy food was requested, and 94% of the food choices in this group were optimal compared to the 0% in the control group. Thus, the delayed delivery of less healthy foods leads to reduced unhealthy consumption, showcasing the behavioral influence held by dining halls. Radnitz and her colleagues suggest further delving into delayed delivery, which seems rather unethical due to the authoritative nature of this concept, but this influence can be analyzed further.

Rather than forcing the choice on the students, dining halls are capable of encouraging certain eating habits. A study from the Journal of Nutrition Education and Behavior showcases this ability with an intervention program where "fruit and vegetable consumption were encouraged; sugar-sweetened beverage consumption was discouraged using physical activity calorie equivalent labeling" (Scourboutakos, 2017). The results of the experiment saw a decreased consumption of sugar-sweetened beverages and a converse increase in fruit and vegetable consumption. This both conveys the impact that dining halls have in food choice as well as how the influence can be used in order to push for healthier diets, a point that will be discussed and researched later.

Limitations and Interests of Food Providers

Moving through the chain of production, food providers are an upper level stakeholder, indirectly impacting diets through the relationship with the dining halls. In particular, "University partnerships are needed to address the desired nutritional improvements" (Vilme, 2015). Food providers act as a limiting factor for the food available to dining halls, and consequently, the choices present for student diets. University food services are at the mercy of the food providers to receive the food necessary. A simplified view may use this argument to

blame the decision of food providers exclusively for the lack of healthy food, however the economic context should be understood before coming to judgment.

The food industry exists on multiple levels. From the consumer perspective, health will be among the most if not the most important. Viewed from the producer, the viability and sustainability of the business model is considerably more important, since a business will inherently be more monetarily inclined. As such even if both sides agree on health standpoints, the economic position should be considered. Vilme and her colleagues mention the existence of economic barriers including "cost and variation in supply and demand" (Vilme, 2015). Through fundamental economics, if there is little demand for a product, relatively higher resource costs will incur. Given "healthier foods cost nearly twice as much as unhealthier foods per serving on average" (Kern, 2017), healthy foods can be less sustainable for the food provider and as a result, the university due to inflated costs. Given this information, the strength of the health decisions made by both the university food services and the food providers is directly related to the economic consequences of those decisions, so both should be thoroughly analyzed before actions are taken.

Administrative Control and Education

Straying away from the direct handling of food, the college can play additional roles in reforming the diets of their students. College administration especially is capable of facilitating events on campus bringing awareness to healthy eating. In a 2007 study on short term food intervention in dining halls, when ""benefit-based messages" promoted targeted foods", "significantly more participants reported that healthful choices were clearly identified in the dining hall" (Peterson, 2007). Based on the research, awareness campaigns addressing the nutritional values of the available food held a clear and positive impact on food selection in

dining halls. This conclusion matches that proposed by the researchers, and showcases the power held in the administration. Any campaign or event must be routed and accepted by the administration, so if the administration can push for similar events, an obvious dietary impact will be made.

The influence of college administration can extend beyond short term campaigns and as far as into the education curriculum. Ali Barzegari, an Iranian researcher for nutrition and health, along with her fellow researchers, surmised from their studies and collegiate expectations the educational responsibilities of universities. They determined the main objective of universities to elicit knowledge in all areas, "so enhancing the nutrition attitudes, knowledge and practices of students have high importance" (Barzegari, 2011). Assuming this obligation does exist for universities, the control of the education system and curriculum is vested into the college administration, or more specifically, the accreditation system for the college. Through the use of transitive relationships, this directly suggests the significance of the college administration, through effective education, on the diet and health of students.

Student Background and Reception

After interpreting the major external stakeholders, it is important to address internal factors to the student which can be summarized as the individual stakeholder. Regardless of the influence and the efforts made by the dining halls, food providers, and administrators to promote healthy eating behaviors, the individual must either have values that reflect these changes or be open to change as a result. This leads into the question of what determines how an individual or student perceives health irrespective of setting.

A dominant influence to personal behaviors are those derived from religion. The Pew Research Center in 2020 determined that 70% of people in the United States are religious

(Kramer, 2022), showcasing the potential widespread influence it can have on diet. An example of the influence on health are the religions that "prescribe or proscribe specific dietary behaviors" (Shatenstein, 1998), including Hinduism's focus on vegetarianism and Islam's focus on Halal. This has obvious implications towards the food choices of religious students and can potentially clash with the standards set by the other stakeholders, which will be analyzed further during research.

An interrelated but different factor involves the cultural and familial influences on individuals and the perception of diet. While not as likely to have as strong of a moral ground as religion, family will inherently have a larger impact than religion due to the constant active influences of parents or other guardians on the views of students. In particular, "frequency of health-specific communication (a) directly influenced health attitudes" and "directly associated with health behaviors" (Baiocchi-Wagner, 2013), implying an effect on dietary behaviors as well. Considering the length of time an individual has lived with their family, especially given health based communication, it is clear that many of the student's health values and norms stem from the family that raised them. Contrasting the psychological impact the family has had on the student from a young age to the university efforts on a more matured individual, the level of influence from individual factors play a large role in diet and are capable of overshadowing the external stakeholders.

Research Methods

Bearing in mind the relevant groups that determine the college diet, the focus of this research intends to use these stakeholders to optimize student diets for maximal academic performance. The first component of the study will delve into the impact diet has on academic performance and what leads to the most optimal diet. A large part of the research will be

conducted through analysis of prior research papers and studies. Subtopics to explore will include, links between cognition and performance, links between nutrition and cognition, and more related fields. Then, by reintroducing the preliminary findings on the relevant stakeholders, the best method and diet for college students will be determined. This will similarly require analysis of previous research in the subject and will include research in the same areas mentioned previously but in the context of a college environment and the established stakeholders. Which unaddressed or mentioned stakeholder should be the focus of improvement? How effective will the improvements prove to be? What additional implications present themselves and what is the impact. For example, grocery stores were not mentioned as stakeholders, but they enable students to cook, introducing a different set of challenges and benefits. Following this line of research, the question of an optimal college diet will be answered.

Conclusion

Diet as defined earlier is an integral part of a healthy being and is critical to the performance of students in an academic environment. The technical topic complements the diet research by providing food in a timely manner, whether in a controlled environment like a restaurant for the first iteration, or large scale delivery for the ultimate goal. Throughout the STS research, the Social Construction of Technology framework was utilized, analyzing the stakeholders in the college diet, providing a base for the eventual goal of optimizing this diet. When accounting the current research and technical project as a conjoined effort, a more complete view of dieting influences are presented, streamlining action plan development once the links between nutrition and performance have been established.

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