AMS Food and Beverage: Optimal Modes of Campus Food Delivery

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An Investigation into...

AMS Food and Beverage: Optimal Modes of Campus Food Delivery

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ABSTRACT

The installation of the New Student Union Building (SUB) creates a vast opportunity for restaurants to take advantage of the food delivery system towards the students of UBC. Ryan Bissell, Executive Chef, and Collyn Chan, New SUB Sustainability Coordinator, have requested the students of APSC 262 to research and identify a vehicle capable of delivering multiple orders throughout campus. The vehicle needed to handle a specific amount of food in a given time period, while being sustainable and user friendly.

The proposed vehicle for this project is the AX-A3 mini golf cart. The AX-A3 meets the criteria given by the client through the following methods: emits zero GHG or CO2, considered a low power consumption vehicle, capable of maneuvring around campus, capable to drive on sidewalks and pedestrian paths, comfortable for the user, and customizable appearance for marketing purposes.The proposed system of delivery meets and exceeds all facets of the project and fits within the image of a sustainable and community conscience organization. The following sections discuss the investigation, design and implementation of the AMS Food Delivery System.

TABLE OF CONTENTS

Abstract ii
List of Abbreviations iv
Introduction 1
Design and Specifications 3
Economic 3
Environmental .....
Social .....
Implementation of Solution 6
Economic .....
Environmental 7
Social 8
Conclusion and Recommendations 9
Conclusion .....
Recommendations .....
References 11
Appendix 12

LIST OF ABBREVIATIONS

AMS	Alma Mater Society
APSC	Applied Science
GHG	Greenhouse Gases
LEED	Leadership in Energy and Environmental Design
LSEV	Low Speed Electric Vehicle
MPGe	Miles Per Gallon Equivalent
SUB	Student Union Building

INTRODUCTION

As students of the Applied Science program at the University of British Columbia, we were introduced to several potential projects to investigate during the 2014 winter session term for the APSC 262 course. This report represent the result of our team's investigation into the AMS Food and Beverage project which looks into optimal modes of campus food delivery. This project was introduced to us by the stakeholders Collyn Chan, New SUB Sustainability Coordinator, and Ryan Bissell, Executive Chef. The scope of this project was to look into various modes of transportation suitable for the food delivery services of the new student union building (SUB), and to perform a triple bottom line analysis on the most feasible mode of transportation. To come up with a suitable vehicle, we were asked to consider various methods of delivery, such as: combustion engine versus electric or hybrid engines, bicycles versus cars, and finally manual labor methods. The chosen mode of delivery must have several key abilities, these include:

- Ability to access variety of roads on campus
- Capacity to carry up to 100 pizzas
- Least amount of emission produced
- Economically a viable option including purchase and maintenance costs
- Energy efficient

Our team decided to tackle this project by considering several different options for modes of delivery. The short listed options were electric tricycles, electric golf carts, and electric vehicles. Although extremely power efficient and environmentally friendly, the electric tricycle was not pursued as a viable option due to its intrinsic lack of performance in harsh winter conditions, as well as its lack of rider protection against the elements and damage from impact. The electric vehicle was also not pursued due to its high cost of purchase and maintenance. Our group chose to focus on the electric golf cart for several key factors:

- Low cost of purchase
- Low cost of maintenance
- Zero emission engine
- Rider protection against elements and physical impact
- Ability to maneuver around campus on various roadways
- Ease of operation
- Adequate cargo capacity

The chosen electric golf cart falls under the category of Low Speed Electric Vehicles (LSEV) under the ICBC motor vehicle regulations and as such, it is optional to be registered or insured (Insurance Corporation of British Columbia, 2014). Another implication is that the LSEV is legally permitted to travel on sidewalks and pedestrian pathways, which is an advantage

of this vehicle as it allows for deliveries to be made to the front doors of various buildings around campus, particularly those which have no road access (Insurance Corporation of British Columbia, 2014).

The following sections of the report will include a triple bottom line analysis of our chosen mode of transportation and will discuss the design, implementation, and recommendations for the optimal mode of food delivery around campus.

DESIGN AND SPECIFICATIONS

ECONOMIC

For the client, there were many important characteristics from an economic standpoint. The vehicle must be easily able to reach all areas on campus in a reasonable amount of time, as well as be able to keep up with the demand of deliveries all day. The vehicle also must be comfortable and easy to operate for the driver thus providing a low turnover rate. Finally it was also important for the vehicle to have low running and maintenance costs and can be easily repaired.

Providing delivery service to every area on campus in a timely matter was a high priority. As most of UBC campus is for pedestrians only, this posed a challenge when it came to delivery service to such places as Marine Drive Residences and Totem Residences as the only way to access these areas would be via Marine Drive, a route that adds a significant amount of time to each delivery. Thus it was an asset to use a small sized vehicle which could easily travel through campus to reach points across campus in a shorter period of time. Another specification for the delivery vehicle was that it should have the ability to keep up with extensive daily demands. This required us to investigate the charge duration of the vehicle as well as the possibility of using more than one delivery vehicle to provide all day deliveries. Another option was to purchase additional batteries that can be charged or left charging while the vehicle is in operation. Investigation into the charging routine of the battery was a definite factor in the economic sustainability of the vehicle as well. Charging a battery to its full capacity is not always a good idea if the longevity of a battery is considered important.

An important aspect for the client was for the vehicle to be comfortable easy to operate for the driver and thus providing a low staff turnover rate. A low turnover rate would mean less time and funds required to train new staff, as well as higher overall job satisfaction. This indicated that we needed to investigate a vehicle which could easily be covered, if not already so, to protect against the elements. In addition to comfort, the delivery vehicle must be easy for the user to operate. Investigations into nearby repair locations and easy accessible vehicle parts are required.

ENVIRONMENTAL

When choosing the design for the delivery vehicle, the choice was highly affected by environmental aspects. The environmental requirements we suggested for the delivery vehicle were reduced GHG emissions, minimal power consumption, and minimized travel distances.

One of the steps to reduce the carbon footprint reduction on campus is to encourage sustainable food practices among students (UBC Sustainability). As a result, one main specification of our delivery vehicle was zero greenhouse gas (GHG) and CO_2 emissions during operation. By implementing a delivery vehicle with zero GHG emissions, we can work towards a better campus and country, since food emissions from the agriculture sector account for 8% of all GHG emissions in Canada. (UBC Sustainability) Additionally, since UBC does not want to produce any GHG emissions by the year 2050, any delivery vehicle that produced GHG's would simply be a temporary solution, and another alternative would need to be sought out in the future.

Another important specification for the delivery vehicle was minimal power consumption during the lifetime of the vehicle. Since 12% of the energy BC Hydro generates comes from oil and gas products (BC Sustainable Energy), any energy draw would be producing emissions, increasing the negative impact of the vehicle. For every kWh of electricity produced by oil and gas energy, 265g of CO_2 is produced (Sims, 2003). Additionally, if the delivery vehicle was to be electric, the charging would have to be efficient measured by kWh/100miles, and the run time per charge, measured by MPGe, must be high.

Another design specification with environmental impact was minimal travel distances for every delivery. Two specifications that impact the travel distance are the size and registration class of the vehicle. A vehicle small enough to reach every area on campus quickly would greatly reduce energy usage since you can cut across campus and park anywhere rather than use conventional streets and parking. In addition to its small size, the vehicle should classify as a low speed vehicle, legally allowing it to travel on the sidewalks and unconventional roadways on campus (Insurance Corporation of British Columbia, 2014). This allows the vehicle to operate significantly less, lowering the energy input per food delivery.

SOCIAL

When looking into the social impact that the low speed electric vehicle will have, we considered several perspectives. For example, driver of the vehicle, or the "user", likely employed by the AMS, will have design concerns that could be very different from the needs of the company purchasing the vehicle: comfort versus ease of vehicle maintenance.

The delivery system could offer new job opportunities to students able to work on campus. The new vehicle should be safe from the elements and collisions, easy to operate, comfortable, and, ideally, should offer a sense of pride. The LSEV we have been considering comes standard with a hardtop, a flip-down front wind-shield, dual safety restraints and seat belts. Because we are directly in touch with the manufacturer, creating models with fabric side panels to protect from the elements and maintain internal temperature is a simple process. Ensuring the maximum level of safety and comfort, relative to the speed and size of the vehicle, we can also ensure high retention rates for the job positions associated with these deliveries. In addition, the

similarity to a standard motor-vehicle makes learning to operate the LSEV a simple and enjoyable task for anyone with a valid driver's license.

The popularity and importance of sustainable development and operations on UBC campus is growing. Projects like the Living Lab and the implementation of SEEDS initiatives are evidence of a collective desire to promote ecological development and awareness on campus. Therefore, we believe that the implementation of one or many LSEVs for the proposed delivery service will not only continue to promote social awareness of sustainable development on campus, but, with carefully planned advertising, it will also allow the new SUB to share this popularity. The success of this idea can be a platform from which other universities can grow their environmental sustainability on campus as well. Also, because this vehicle is small enough to travel through campus instead of around it, its potential to arrive quicker and closer to your door than other delivery services increases the popularity of the new SUB as well.

Before the delivery service that is to be made available with the opening of the new Student Union Building was proposed, there was so such delivery service available for food produced by the AMS. The features of this new program will be completely novel and as such, the administration must be ready to make improvements over the next few years as these systems are broken in. That being said, considering the social impacts as we have laid them out is a very good place to start.

IMPLEMENTATION OF SOLUTION

ECONOMIC

The idea of using an electric golf cart satisfies all of our design requirements as described above. It can very easily reach all areas on campus easily, as well as keep up with the demand of deliveries. The vehicle has the option to be covered as well as being easy to operate. Finally any replacement parts for the recommended vehicle are easy to come by and can be repaired at many locations around the lower mainland.

The recommended vehicle is classified by ICBC as a low speed vehicle therefore it is allowed to be driven on pedestrian walkways (Insurance Corporation of British Columbia, 2014). This will allow the vehicle to easily reach all areas of campus without having to go around campus on roadways. At 81cm wide the electric golf cart is also able to pass through the pylons around campus which block motor vehicles from entering onto pedestrian walkways. The battery life of this electric vehicle is approximately 6 hours of continuous run time. With this we estimate that this will work out to approximately 8 hours of delivery service for one vehicle. With one of these vehicles we would recommend an extra battery to keep up with the demand of a 12 hour delivery day, or the recommendation of two carts.

With the option of a removable cover, this allows the recommended vehicle to be completely covered in the winter and can be removed during the warmer months. This would allow the driver to remain comfortable during the winter months. As the vehicle is a low speed electric golf cart it is very easy to operate and does not require a driver's license to operate. Due to its comfort and easy usability we predict that this would create a low staff turnover rate, thus reducing time and funds required to train new staff.

Finally in terms of running costs for the vehicle, the cost per 25km is $0.109 with the cart using $0.1 per kWh. We estimate this to be an annual electricity cost of approximately $124.10 a year per cart. By converting this value into a miles-per-gallon equivalent (MPGe) for comparison purposes, the recommended vehicle is 276.6 MPGe. This value can be compared to the leading electric car at 126 MPGe (US Department of Energy, 2014). Because the recommended vehicle is a recreational electric golf cart there are numerous different repair locations within the lower mainland, reducing the costs of any required repairs needed for the vehicle. Finally because the recommended vehicle is classified as a low speed vehicle (Insurance Corporation of British Columbia, 2014) it is not required to be insured.

ENVIRONMENTAL

In order to be an environmentally sustainable solution, the delivery vehicle must make an improvement upon the system currently in place, which is primarily delivery from a competitor on Dunbar Street, 5.3km from the UBC campus, who does not currently have a sustainability plan for their delivery in Canada. On the other hand, our vehicle recommendation, of an electric golf cart is an excellent option in terms of sustainability. In this section, the vehicles GHG and carbon dioxide emissions, its power consumption and a comparison to some leading vehicles on the market will be examined.

For a calculation of GHG emissions, no GHG's are emitted during operation of the vehicle, since electric power does not generate GHG's directly. Indirectly, since the vehicle consumes 3.84kWh per charge, the electricity provider produces 122g of CO2 during every battery charge. A 2014 Smart fortwo would produce 11.42 kg of CO_2 (EIA, 2013) while traveling the same distance (US Department of Energy, 2014). The golf cart produces at least 93 times less CO_2. Over a year, each delivery vehicle will produce 44.5kg of carbon indirectly.

During charging, the vehicle consumes 3.84kWh. Assuming 48.4 miles per charge, the vehicle consumes 7.92kWh/100 miles using the advertised specifications. As a comparison, the city efficiency of the 2012 Chevrolet Spark, the most efficient electric car in its year in terms of efficiency, is 26kWh / 100 miles (US Department of Energy, 2014). The usage of a similar vehicle, the Garia electric golf cart is 20kWh / 100 miles, showing that the delivery vehicle recommended has excellent efficiency (Garia, 2014). One reason that the consumption of the recommended delivery vehicle is so low is because of minimal engine output. Although this causes the delivery vehicle to posses a lower top speed, this shouldn't inhibit its use on campus.

A comparison of miles-per-gallon equivalent (MPGe) is necessary in order to determine which vehicle produces the most work for the amount of energy output, and gives a suitable comparison to suggest the efficiency of the vehicle. The MPGe of the recommended delivery vehicle is 276.6 MPGe. A similar vehicle, the Garia electric golf cart, achieves 170MPGe (Garia, 2014), and the leading electric car is 126MPGe (US Department of Energy, 2014).

Another important design consideration of the vehicle is width. The width of the recommended car is 0.88m, allowing it to easily access all of campus, considerably cutting down delivery distances.

Based on these values, the vehicle recommended is an excellent choice in terms of environmental sustainability. The vehicle produces minimal GHG's, travels considerable distance on the energy used, and can easily reach any place on campus.

SOCIAL

The implementation of this idea will be novel and revolutionary. No other campus provides a sustainable delivery service that could include an entire range of cuisines, from sushi to burgers and pizza, delivered right to your door. With growing awareness and concern on campus for environmental issues, the image of an eco and user-friendly delivery vehicle will last in the mind of our informed student body.

As part of our presentation of this idea, we included a campus map (see appendix). We highlighted resident dense routes so that the vehicle and the initiatives of the new SUB will be noticed. The top speeds of the vehicle are around 13 km/h, so not only will it be safe to drive in these areas, but it will also advertise itself. Also, it is a worthwhile marketing idea to advertise on the new website and perhaps the car itself, that the vehicle employed the new SUB is a zero-emissions vehicle.

Once ordered and implemented, part of our plan is to survey the students who live along these routes or in areas commonly delivered to. These surveys will be implemented to assess students' and residents' attitudes towards of electric vehicles. During this trial period, we will also assess the safety of operations and electricity use in the vehicle: including charging, service and repair, and responding to vehicles that have been involved in collisions. The trial will be looking at things like planning requirements, electricity market arrangements, parking and other issues, and investigating whether they affect the efficient roll-out of our electric vehicle as well.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Our chosen vehicle, the LSEV golf cart, is a robust, user friendly, environmentally conscious, and economically sound vehicle that is ideal for implementation within the new SUB food delivery services. The AMS Food and Beverage will greatly benefit from the low cost of purchase, under $5000.00, and the low cost of maintenance, under $300.00 per year. The lifetime of the vehicle is expected to exceed 10 years and upon decommissioning, it can be donated to student clubs around campus for promotional and marketing purposes, or donated to technical departments such as the mechanical engineering or the electrical engineering department for testing or project purposes.

The zero emission engine equipped on the vehicle means a greener campus for all students, and promoting its environmentally friendly operation could be a great marketing tool for the SUB. The high power efficiency of the vehicle is in line with the LEED Platinum standards adopted by the new SUB, and as students across the campus recognize this fact, it may encourage some to pursue other green projects that can benefit the campus and the campus environment.

In addition to the economic, social, and environmental benefits of the LSEV golf cart, the AMS Food and Beverage services will also benefit from logistical advantages that are innate with this vehicle. Its ability to zoom around the campus, through various pedestrian pathways and sidewalks, will greatly reduce the time duration of deliveries which will result in a higher turnaround ratio for sales, as well as a happier client who will be more inclined to make future purchases from the SUB, instead of reaching out to other local eateries. The ease of operation of the vehicle, as well as the “cool factor” of driving a golf cart around the campus, will also help in the retention of the employee who will be operating the vehicle, reducing the time and money spent on hiring and training new employees.

RECOMMENDATIONS

It is our recommendation that the AMS Food and Beverage look into purchasing two of these vehicles so they can have one in service for the entirety of their operating hours; however, if the purchase of two is not within the budget, then we recommend a set routine of charging the vehicle overnight so that it is always fully charged at the start of the day, as well as charging in between deliveries, so that the vehicle could stay in operation for the duration of the operating hours. In addition to above, it is also worth mentioning that the AMS Food and Beverage services could observe nominal savings by charging the vehicle overnight as the cost of

electricity is less during off peak hours. A further recommendation could be to consider the purchase of an extra battery pack to be charged on site and used as replacement battery for when the operating batteries fall below the minimum level of charge. This way, with a simple switch of batteries, the vehicle can maintain operation through the opening hours.

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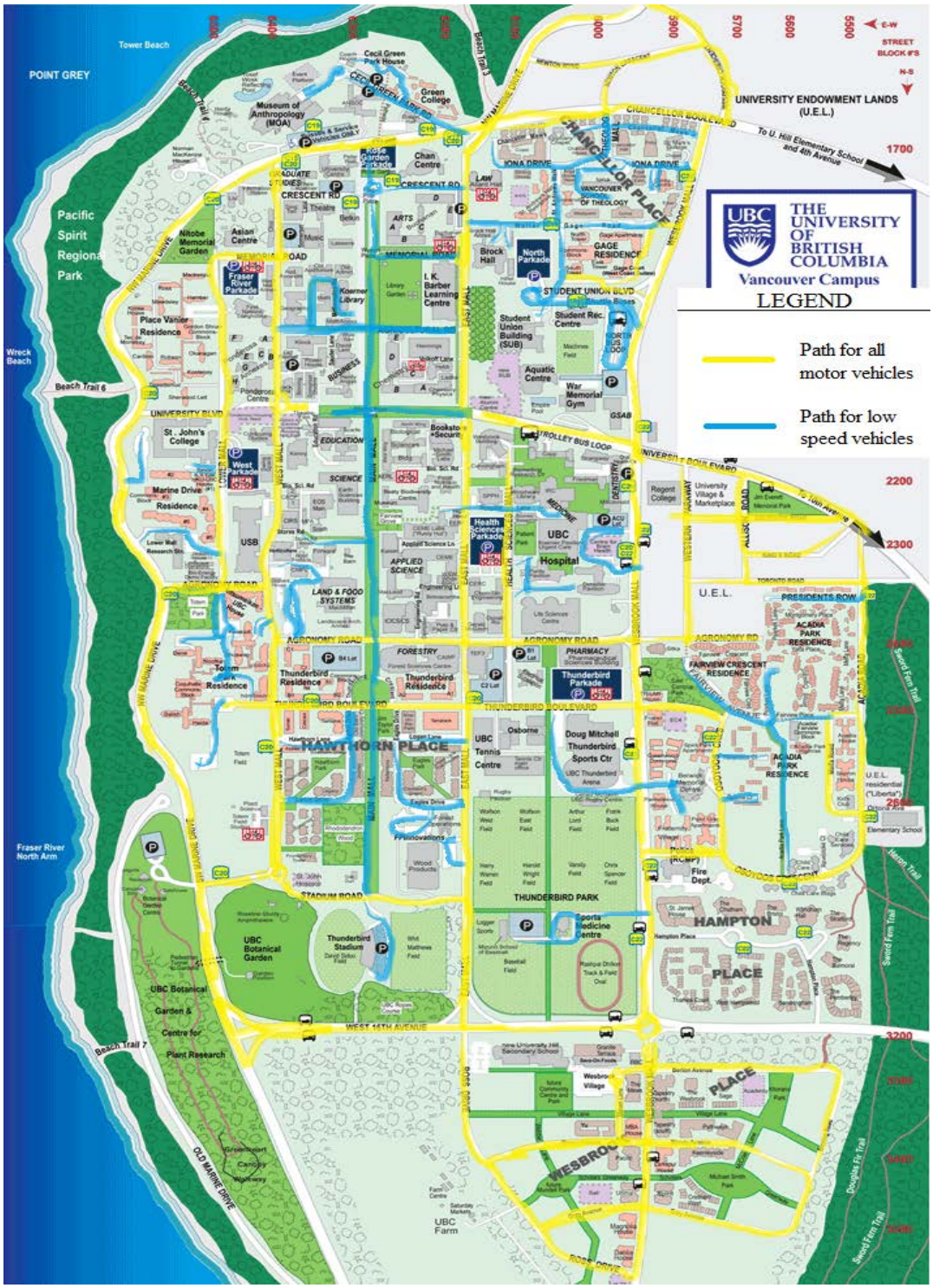
APPENDIX



A map of the available routes to take at the UBC campus