

## Electric-assist Bicycle Retrofits in the City of Chicago

Andrew Beck, Nalini Priya Uppari

The City of Chicago is currently facing numerous short- and long-term sustainability challenges within its transportation system. Traffic and congestion are abundant; aging infrastructure repairs demand serious attention; commuters everywhere spend sedentary hours of their lives sitting in single-rider cars. Slowly but surely, CO<sub>2</sub> emissions and public health impacts rooted in combustion byproducts – NO<sub>x</sub>, SO<sub>2</sub>, PM2.5, PM10, VOCs, etc. – have become the norm in city transit. These health impacts equate to millions of dollars in healthcare costs and hundreds of attributable deaths. Fully acknowledging the convenience, reliability, and ease of operation of the technologies associated with these problems, we propose an alternative: electric-assisted “pedelec” retrofit technologies, manufactured here in Chicago.

Our organization looks to create a technology partnership with an existing producer of this technology – Superpedestrian, maker of the Copenhagen Wheel – and offer them the advantages conferred by the framework of digital manufacturing. In addition, our strategic partnerships with the city government will facilitate the Divvy bikeshare program serving as a testing ground to collect use-phase product operations data for further prototyping. We plan to partner with the Divvy bike-share program to convert some 10% of their bicycles into electric-pedal-assisted models. These bikes do not propel themselves under any circumstances; the rider must be pedaling, and from there the sensor and control system will notify the electric motor to assist the rider. These retrofitted models will sustain speeds of up to 20mph over the course of >20mi, in accordance with state and federal law. This speed, affordability (in partnership with Divvy), and accessibility will increase the equity and accessibility of transit for all Chicagoans with access to the bike-share, which is currently expanding to double its previous footprint.

With respect to public health, according to the U.S Department of Health and Human Services, physically inactive lifestyles are a major public health challenge. Physical inactivity is an well-documented risk factor contributing to chronic diseases that kill most Americans, including coronary heart disease, stroke, some cancers, diabetes, and depression. Inactive lifestyles are responsible for about 200,000 deaths in the US each year, second only to tobacco, which kills around 400,000 ([USDHHS, 1996](#); [McGinnis and Foegen, 1993](#)). Whereas less than 20% of adults are smokers, more than 70% had physical inactivity lifestyle([USDHHS, 2000](#)). Physical inactivity costs more than \$77 billion every year in the United States in direct medical expenses alone ([Pratt et al., 2000](#)). Lastly, the largest health benefits are for those who move moderate amounts of physical activity; there are lower of moving from moderate to high levels.” ([Pate et al., 1995](#); [USDHHS, 1996](#)) With all this in mind, promoting a more active daily commute via bicycles has the potential to confer enormous positive benefits in the long-term.

In terms of climate change mitigation and energy security, the efficiency of utilizing electric-assisted bikes is manifold. Not only do they confer enormous direct per-rider-mile efficiency gains over single-rider cars, but they also have a significantly smaller footprint per rider, and thereby alleviate traffic and the associated waste of energy. Simultaneously, by functioning on electricity via rechargeable Li-ion batteries, the “fuel” for e-bikes can be generated locally, and is not subject to geopolitical conflict or foreign interests. All of these benefits are passed onto Chicago, along with various others.

Our simple scaling of an already-effective technology aligns well with the Chicago Streets for Cycling Plan 2020, and the mission of the Chicago Complete Streets initiative. By integrating into existing, recently expanded, and planned Divvy infrastructure, we will impact the daily lives of Chicagoans by providing an affordable, accessible transit option that is expedient and highly sustainable. In terms of existing and planned infrastructure, the city currently has about 200 miles of on-street protected, buffered, and shared bike lanes, with off-street paths totaling 26 miles(including the 18.5 miles Lakefront trail). In partnership with our technology, the Cycling Plan 2020’s call for 645 miles of bike lane network could become much more highly demanded, and provide Chicagoans with safe and easy transportation for longer trips through city streets. With households in the Chicago region spending an average of 17 percent of their budgets - or \$7,500 per year - on transportation, pedelec technologies can offer cost savings within the first year to many families. The positive feedloop of bike ridership and quality of bike infrastructure will also entice more Millennials to move to Chicago, further bringing the city revenue beyond just our operations.

We planned to locate our manufacturing facility in Pilsen, on the lower west side of Chicago. The community area which is connected CTA, Metra transportation facility and surrounded by the educational institution. This pedelec retrofit technology will foster for the innovative design and execute our marketing plan in order to fill the gap between the manufacturing and designing the product according to the customer needs by feedback. We hire sales and marketing team and partner with the public relation teams. Our priority is the quality of the product and customer service in order to compete the global manufacturing market. We foster our company to be future sustainability leaders for the innovation technology integrating with the digital manufacturing to make the manufacturing more economical and feasible..

According to the U.S Census statistics 1,213,901 employees in City of Chicago 26.7 percent preferred public transportation, 1.3 percent took bikes , 6.4 percent preferred to walk and 4.2 percent worked online from home. Based on the survey of the survey on the electric bikes in the North America, we analyzed that there is an increasing demand for the pedelec bikes for school and work could able to travel long distances when compared to the shorter trips. Our marketing plan include the advocacy campaigns for smart e-bikes and reach out the public using social networking sites. We increase our market by educating students using e-bikes and health benefits and providing discounts and offer internship in order to promote digital manufacturing. In addition, our sales team mainly focused to reach out the customer the make our project more beneficial to the students, motor bike enthusiast, employees, that have an impact on Chicago the use of public transportation.

In order to incorporate the digital manufacturing into iPhone app we propose to incorporate the sensor which enables the electric bikes for navigation for the routes of the bike lanes, weather alters, charging station availability, electrical pedal and brake control systems when the rider exceed the speed limit we foster for the safety of the drivers and reduce the speed automatically. This is an innovative technology for big data and electrical e –bikes in order to reach the customer we expand our business to partnership with Divvy bikes. By capturing data from the design, fabrication, assembly, and evaluation phases of our manufacturing operations, we can utilize a host of CAD and CAE tools, along with other data analytics platforms, to make continuous improvements upon the product. A prime example of this could be lightweighting through producing a digital twin, and continuing to prototype even as the product is on the market [source]. By collaborating with SuperPedestrian, we will already have access to a suite of sensors built into the final product, communicated back to us for analysis through the wireless connectivity of the pedelec hub [source]. This data, recorded by an accelerometer, a “torque sensor, GPRS, and a sensor kit that monitors for CO, NOx, noise (db), relative humidity and temperature” will enable mapping of city-wide trends in each of these measurements. This could better inform riders of routes less hazardous to their well-being, or assist in the optimization of motor output during adverse conditions.

According to Jamerson’s study of the United States, the amount of interest in purchasing e-bikes between July 2011 and June 2012 was approximately 100,000. In the year 2016, sales are projected to reach 185,000, as there are more manufacturers and retailers entering the market each year. Within 20 years, the number could be as high as 2 million, and the United States will be one of the top markets for electric bicycles in the world, which will include the Copenhagen Wheel we aim to manufacture. Our marketing plan include the advocacy campaigns for smart e-bikes and reach out the public using social networking sites. We increase our market by educating students using e-bikes and health benefits and providing discounts and offer internship in order to promote digital manufacturing. In addition, our sales team mainly focused to reach out the customer the make our project more beneficial to the students, motor bike enthusiast, employees, that have an impact on Chicago the use of public transportation. Supply chain for the production delivery and quality management mainly depends on the suppliers we collaborated with the local suppliers for the manufacturing of the retrofit kit and partnered with digital manufacturing companies to incorporate sensors and distributors to the retail bike shop in order to reach out the customer.

## Works Cited

1. Web. 17 Aug. 2015. <<http://www1.ncdc.noaa.gov/pub/data/ccd-data/pctposrank.txt>>
2. *Climate Change 2014: Mitigation of Climate Change: IPCC Working Group III Contribution to AR5*. Print.
3. “Electric Bike Tech Makes Power-Assisted Wheelchairs Way More Affordable.” *Gizmodo*. Web. 17 Aug. 2015. <<http://gizmodo.com/5952107/electric-bike-tech-makes-power-assisted-wheelchairs-way-more-affordable>>
4. “Electric Bike, Bicycle Assist, Pedal Assist, All In One Design, Urban Cycling | Smart Wheel.” *FlyKly Smart Wheel*. Web. 18 Aug. 2015. <<http://flykly.com/smart-wheel>>
5. “Lightweighting | Sustainability Workshop.” *Lightweighting | Sustainability Workshop*. Web. 18 Aug. 2015. <<http://sustainabilityworkshop.autodesk.com/products/lightweighting>>
6. “Meet Divvy.” *Divvy Data*. Web. 18 Aug. 2015. <<https://www.divvybikes.com/data>>
7. “Superpedestrian - The Copenhagen Wheel.” *Superpedestrian*. Web. 18 Aug. 2015. <<https://superpedestrian.com/>>
8. “Yamaha JWX-2 Wheelchair Power Assist Unit Can Be Attached to Almost Any Wheelchair.” *DigInfo TV*. Web. 17 Aug. 2015. <<http://www.diginfo.tv/v/12-0176-r-en.php>>
9. “Copenhagen Wheel Project.” *copenhagen wheel project*. Web. 18 Aug. 2015. <http://senseable.mit.edu/copenhagenwheel/wheel.html>
10. <http://www.cityofchicago.org/city/en/depts/cdot/provdrs/bike.html>
11. <http://www.sciencedirect.com/science/article/pii/S0965856403001058#>
12. <http://electricvehicle.ieee.org/2015/05/21/our-transportation-is-literally-killing-us-can-battery-electric-vehicles-be-a-better-solution/>
13. <http://ehp.niehs.nih.gov/1103440/#t>