Analysis of On-Street Parking Opportunities in Madison, Wisconsin

The economic, political, social and educational hubs of Madison, Wisconsin are centered geographically on an isthmus, situated between two lakes. A city of some 235,000 people and center to a county of approximately 500,000 residents, Madison's central core is home to the Wisconsin State Capitol, City, County and State government offices, a thriving commercial and retail core, and is home to the University of Wisconsin-Madison, serving some 40,000+ students and a faculty and staff of more than 16,000. Transportation and parking access are critical components of the success of this area and the City as a whole.

The City of Madison is fortunate to be served by a robust and professional traffic engineering civilian staff that have meticulously compiled data in its quest for system efficiency. Parking Utility Manager Thomas Woznick and his staff have generously provided us with years of raw data and analysis to assist us in our examination of the City's current system. We are incredibly appreciative of their interest and willingness to assist our research.

System Background

Given the City's constrained geography and density of usages, the City of Madison experiences high demand for parking within its downtown core's limited availability of space. The City has 1,446 total on-street meters, along with 203 off-street meters that are regulated by the City's Parking Utility. The utility also oversees a residential parking permit program and five city-owned and operated parking ramps to manage the demand for short term and long term parking across residential, employment and recreation/event parking demands. Annual revenues from on-street meters have averaged between $1.1 and $1.4 million annually. The City currently uses fixed-prices for their on-street meters and most meters have a rate of $1.75 per hour. Parking ramps are variably priced, but are priced lower than the on-street meters to entice long-term parkers to utilize the ramps and leave the on-street meters for short-term parkers. Meter enforcement hours are uniform from 8AM-6PM and are a mix mostly of 25 minute, 1 hour and 2 hour parking limits (although a select few meters are longer, up to 10 hours). Enforcement of street parking is overseen by 28 FTE parking enforcement officers through the City of Madison's Police Department, and paid for through inter-agency charges to the Parking Utility. The average wage with benefits is $52,520 per FTE enforcement officer.

In 2010, the City of Madison undertook an RFP (Request For Proposal) for a credit-card enabled, multi-space, pay by meter on-street parking system. The winning vendor was Metric Parking. To date, the City has purchased 100 kiosks (92 installed, 8 awaiting installation) at a cost of roughly $8,000 per kiosk and a total investment since 2010 of roughly $1 million for purchase and installation of equipment. Currently, 694 of the 1446 on-street parking meters are covered by the pay-by-space kiosks. The system does not use license plate data, instead each space is labeled with a unique number posted at each parking space and users enter that unique space number into the kiosk upon payment. There is no requirement to place a ticket of the windshield of the vehicle. Many signage polls have further been upgraded into bicycle racks to allow the most usage possible of the sidewalks and curbsides. Parking enforcement officers have handheld computers that constantly update and inform the officer where and when expired meters occur so they may write tickets to offending vehicles.

The City has authorized an additional 12 kiosks to be purchased in 2014 and plan for an additional 12 kiosks in 2015. These additional kiosks have been budgeted to cost approximately $10,000 per kiosk.

The utility also has authorized for 2014 some 500+ single-space, credit card capable single-space meters to be installed in 2015 at an initial capital investment of $400-$500 per meter, with a total authorization of $400,000.

The utility held off on purchasing credit-card enabled, single-space meters in previous years due to their untested nature, questions of their operability in Wisconsin's cold weather climate, and their expense when initially introduced into the marketplace. The technology has improved and the cost per meter has now fallen sufficiently where City Utility staff are willing to introduce these single-space meters into the parking system. Additionally, the City has planned these meter for piecemeal installation where multi-space meters do not make economic sense. The timeline is planned for a written and legislatively approved RFP to be completed by early summer, 2014 to enable a vendor bidding process to be completed and a purchasing contract to be executed by year-end of 2014.

Project Goals

We wish to explore the capability and outlook of the city's newly installed system to go further in pricing and usage efficiency. For over 30 years, the Utility has consistently kept usage demand data that they have provided to us for the years 2009-2013. We have attempted to build a working prototype of a variable pricing model of the city's downtown core and explore the costs and policy considerations to successfully implement such a pricing system. We have also explored technology add-ons like vehicle sensing devices to further optimize customer experience for the meter pricing and traffic circulation of the system. Our major considerations in exploring this sensor technology is its cost and relative payback and the ability of the technology to reliably operate in Wisconsin's cold-weather climate, given the propensity for limited winter daylight and ice packed onto the pavement. Our goals in exploring a variable price meter system is to evaluate further capacities for revenue streams for the utility that would enhance its long term financial solvency as an enterprise revenue agency.

Initial Analysis

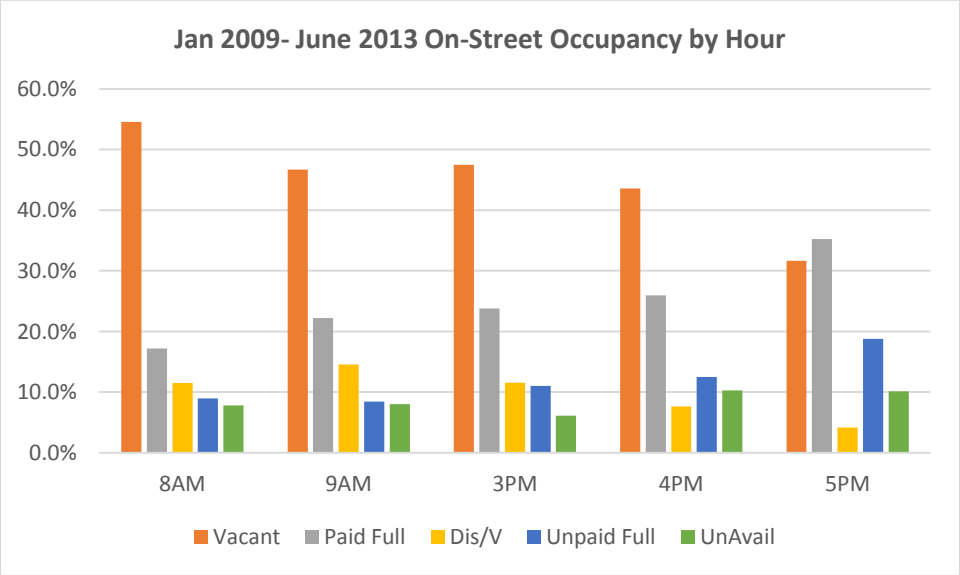
City Utility staff believe that their existing system provided by Metric Parking is technologically capable of handling the programming and data storage required for a variable-priced meter system. While the software is proprietary to Metric Parking, the City of Madison purchased the server the system is housed on and has recently been provided the software access capability from the vendor to change the pricing structure directly. City staff currently need training from the vendor to successfully implement software updates, a critical next step for optimization of the system. Staff believe that a variable pricing model could be regularly updated on a quarterly basis (every three month) with minimal system or customer disturbance. The software and pricing updates are able to be centrally updated to the kiosks, and the kiosks are programmed with two-way communication capability between the server and other kiosks, enabling users to purchase or add parking time to their meters from any kiosk in the system, and enabling pricing updates to be recognized system-wide. Future single-space meters are envisioned to be completed integrated into the existing multi-space system.

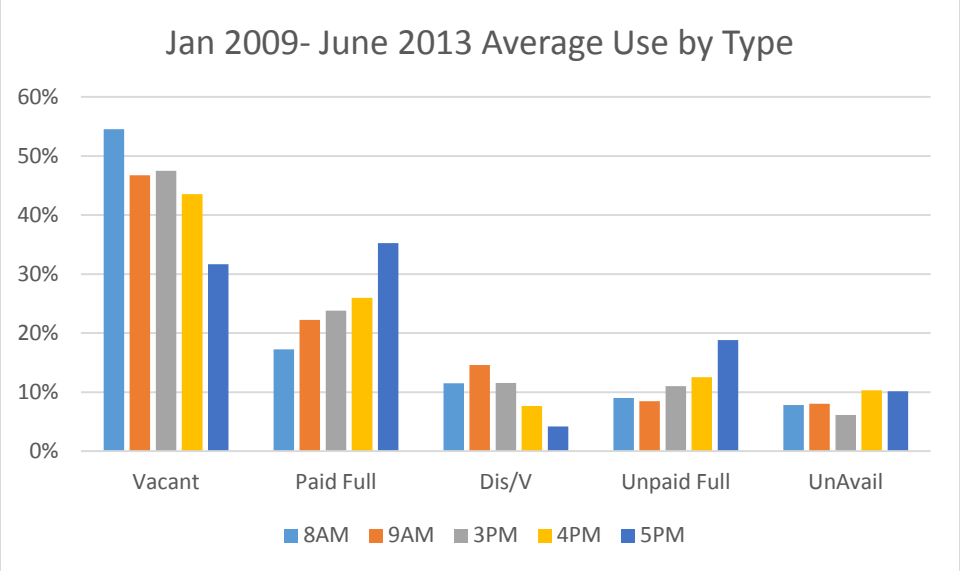
Parking Demand Analysis

Staff has maintained extensive parking demand surveys for many years. Survey data provided to us sampled on-street meter usage monthly for some 450+ meters, spread across 58 zones. Sample data was taken each month and recorded for the hours of 8AM, 9AM, 3PM, 4PM and 5PM. We have

compiled the monthly data for each year and tracked demand for each zone throughout January 2009-June 2013. We have excluded from our counts parking stalls that were unavailable or out of order at the time a survey was taken. We have attached additional files with our extensive data and analysis in our attempt to model demand and a potential future variable-rate price for on-street parking for the City of Madison.

Overall, demand for on street parking is highest in the late afternoon and early evening. Who is paying to park continues relatively consistently throughout the day and vacancy is also consistent until the late afternoon. Further analysis on the system can be viewed in finer detail within our supplemental report.





Example of Survey Data- 8AM Survey, 2009-2013

8AM System Data Season	Vacant	Paid Full	Dis/H	Unpaid Full	Unavail	Grand Total
Winter	70.04%	10.77%	1.03%	9.59%	8.56%	100.00%
Spring	66.08%	13.82%	3.55%	6.65%	9.90%	100.00%
Summer	60.44%	11.07%	5.98%	9.37%	13.14%	100.00%
Fall	48.08%	22.49%	7.74%	16.37%	5.31%	100.00%
Grand Total	**61.16%**	**14.54%**	**4.58%**	**10.50%**	**9.23%**	**100.00%**

Disabled Parking: A Question of Free Riders

A major observed pricing system inefficiency to Madison's on-street meter system is the high frequency of individuals utilizing Disabled/Veteran Tags to park for extended durations of time for no charge on-street.

Under Wisconsin State Statute 346.50(2a);
"a motor vehicle bearing special registration plates issued under s. 341.14 (1a), (1e), (1m), or (1q) or a motor vehicle, other than a motorcycle, upon which a special identification card issued under s. 343.51 is displayed or a motor vehicle registered in another jurisdiction upon which is displayed a registration plate, a card or an emblem issued by the other jurisdiction designating the vehicle as a vehicle used by a physically disabled person is exempt from any ordinance imposing time limitations on parking in any street or highway zone and parking lot, whether municipally owned or leased, or both municipally owned and leased or a parking place owned or leased, or both owned and leased by a municipal parking utility, with one-half hour or more limitation but otherwise is subject to the laws relating to parking. Where the time limitation on a metered stall is one-half hour or more, no meter payment is required."

Parking surveys consistently find some 15% of on-street meters occupied for free by individuals with disability tags, estimated to consume some 55% of used parking stalls. In 2010, City of Madison Parking Utility staff estimated that if these parkers were paying to park at meters, the system would receive some $800,000 in additional annual revenue -a significant effect, given the $1.4 million annual revenue the utility has been receiving.[1]

Laws similar to the one in effect in Wisconsin are prevalent in many states and are politically fraught in any attempts to change. Illinois is one of the few states that successfully changed established laws to remove the free parking situation largely due to advocacy by motivated individuals and through a series of muckraking journalism that documented significant abuse of the system.[2] It is unknown whether

[1] Please see Appendix A for City of Madison analysis
[2] http://theexpiredmeter.com/2013/08/a-short-history-on-how-disabilty-parking-laws-changed-in-illinois/

there would be political support to change this state law, but its effects on Madison's parking utility revenue are profound.

Adding Parking Sensors: A Discussion on Technology

Dynamic parking control and real-time parking information can be extremely helpful for both municipal administration and citizens. To gather that information and enable citizens to access parking information in a real-time manner is difficult for any city. From a technological perspective, it is manageable and can be achieved. However, whether a municipality finds the costs worth the benefits are inherently subjective. The following is a discussion of the types of parking sensors that are available currently on the market and technology considerations.

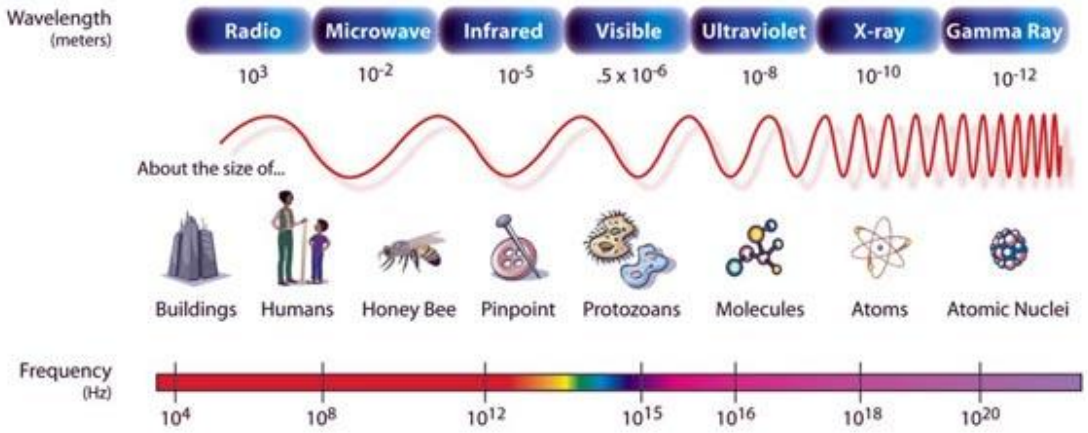


Figure 1 Bandwidth of Electromagnetic Wave[3]

Sensing methods

As for sensing, the ultimate goal is to retrieve the status of some object. For parking, an autonomous and remote sensing method is in need to get the basic information of vacancy in every single space. Sensors can be divided into two main categories, proactive and passive. Listed below are the most popular choices for short-distant and low-cost sensing method. Sensors have their different features when employing various bandwidth of detection method. Robust, accuracy and weather/climate sensitivity are factors should be taken into consideration when choosing sensing method.

Ultrasonic

Ultrasonic is a proactive method of sensing, generating ultrasound itself to detect the existence of certain object. Ultrasonic transmit sound waves between 25KHz and 50KHz[4]. If sensing an object, the reflection of sound wave will come back to the sensor. Presence/absence of vehicle at a certain space can be told from the different reflection diagram. Though easy to install and cost-efficient to operate, there are certain drawback of ultrasonic sensor. Ultrasonic sensors are sensitive to temperature and

[3] http://chemwiki.ucdavis.edu/Physical_Chemistry/Spectroscopy/Fundamentals/Electromagnetic_Radiation
[4] *Smart Parking System Architecture Using Ultrasonic Detector*, Amin Kianpisheh etc.

consume relatively more energy than passive sensors. Thus, battery based sensors will easily eat up the battery and raise the operating cost. In this sense, sensors have to be wired. Also, outdoor deployment in cold areas may obstruct the accuracy of the sensors.

Most of the cases, ultrasonic sensors are adopted for indoor parking because of its low cost and implementation convenience.

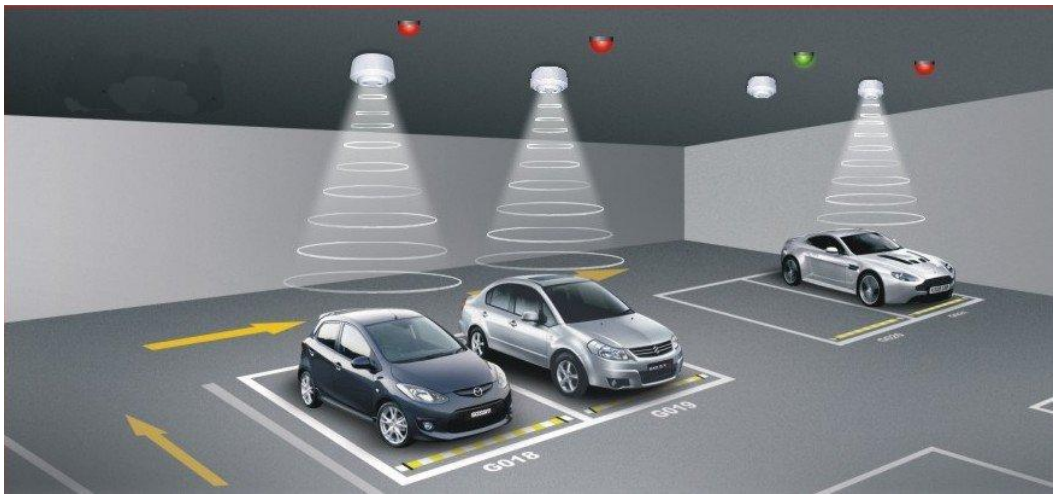


Figure 2 Ultrasonic Sensor

Optical

Optical sensors are the most intuitive sensors, and they functions are people's eye. Sensor can be placed either beneath or above the parking space, and optical sensor is a passive detection method, which consumes less energy than proactive ones. Usually, optical sensor will consist a camera and a processor. The camera will capture the light lumen incoming the sensor and let the processor determine whether there is a vehicle parked in the spot. If the spot suddenly become dark, it is highly possible that a vehicle has arrived and parked in the spot. Better optical sensor may involve camera footage and apply the pattern recognition techniques to better verify the presence of a vehicle. However, there are fatal flaws in sole optical sensor system. It is highly sensitive to weather condition and is lack of accuracy determining whether the object detected is a vehicle or not. If better technologies are employed to improve accuracy, cost will become another lethal concern.**Electromagnetic field**

This is a more delicate and accurate method to sense vehicle. Electromagnetic field sensor can be either proactive or passive. As a proactive electromagnetic sensor, the sensor will generate the local

electromagnetic field, and the field is sensitive to metal object. The presence of a metal object like vehicle will reflect the electromagnetic wave generated by the sensor. By detecting the reflection of the electromagnetic wave, the sensor can tell the existence of the vehicle. There are also passive electromagnetic sensors, which monitor the earth magnetic field instead of generates a local one. The electromagnetic field sensor is all-day and all-weather, and more accurate than other types of sensing.

Figure 3 Electromagnetic Sensor[5]

Sensors Comparison

Sensors	Installation	Operation Cost	Robust and Accuracy
Ultrasonic	Easy	Low	Low
Optical	Hard	Median	Low
Electromagnetic	Hard	High	High

Integrated system

A parking sensor is the eye to the entire fare parking system body. However, the heart and brain are still needed to make the system work Typically, the system hardware is organized into three main components, the sensor network, the central server and the mobile device[6]. The sensor will detect the vehicle, and transmit the information to the kiosk. The 3G/4G connected kiosk will transmit the information to the control center where all the information are displayed and monitored.

Madison network connectivity currently has 10 kiosks on fiber network, 80 are on GPRS (General Packet Radio Service) wireless connection and the other 10 in trial with a CDMA (Code Division Multiple Access) Wireless connection, giving the system several options for wireless connectivity and a controlled integrated system is feasible.

[5] http://sfpark.org/2012/05/01/sfpark-parking-sensor-installation-and-removal/
[6] *A Reservation-based Smart Parking System*, Hongwei Wang, University of Nebraska

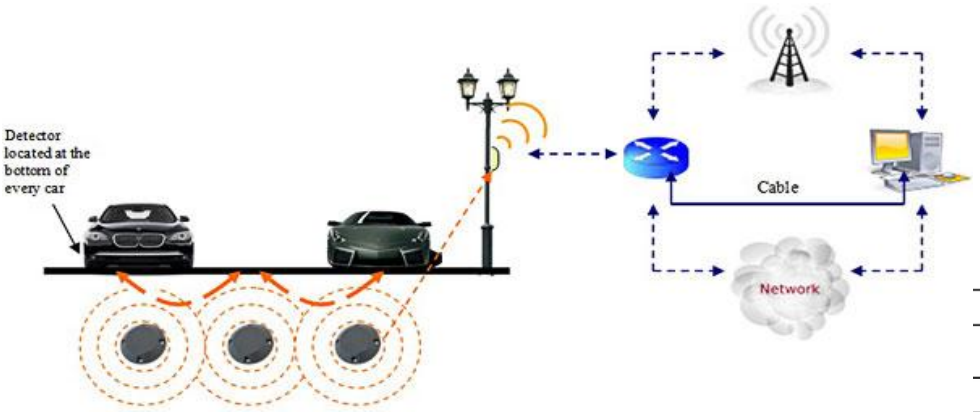


Figure 4 Integrated System Diagram[7]

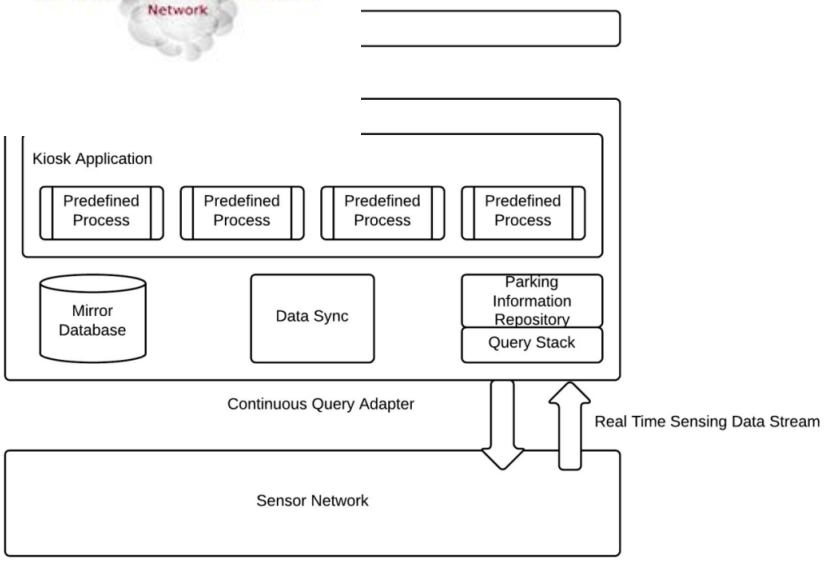


Figure 5 System Structure[4]

Implementation concern

Implementing smart parking system involves constant upgrades and system compatibility testing. Considering the capability of the legacy system, Madison's Parking Utility should implement build out of their existing system in a way that is sustainable, easily scalable, staffed with available operating resources and mostly important, compatible within the operating constraints of the existing legacy system. Hiring a viable project team or vendor to manage the usually proprietary system programming is another factor the city council should take into consideration when planning for such a project.

Summary

The City of Madison has the technological capacity to build out their existing on-street meter pricing for parking sensors and variable pricing should they choose to. On-street parking shows moderate demand for use and further market analysis would be helpful to look at expanding collection hours off-peak on nights and weekends to capitalize on revenue. Demand data shows an uptick in on-street parking in the late afternoon and early evening hours.

Madison has already purchased and installed the bulk of the technology needed to expand their service and technology capacity, any additional costs for variable pricing capacity should be minimal, however, sensors could be a costly addition with unknown durability within Wisconsin's climate. Further evaluation of costs should be undertaken to assess system benefit, especially regarding the necessity for any continuing vendor maintenance and any proprietary software capacities that are maintained by a third-party vendor. Additionally, any potential sensor system should be installed on an ad-hoc, test basis during variable and extreme weather activity and thoroughly stress-tested with the legacy system before any system ad-on is contracted or purchased.

[7] http://www.stee.stengg.com/group/satcom/product/sensor/agilsense_parking_system.html

Appendix A

Source: City of Madison Parking Utility