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Abstract for Paper Presentation Proposal:
Transportation and the Environment
Cars, Parking and Sustainability

Cars are now moving in the direction of becoming good for the environment again – going back to their electric roots. The majority of vehicles pre 1910 were electric vehicles and the first commercial parking structures were for electric cabs in 1897. The beginning of the automobile was as the environmental savior of our cities, saving us from the illnesses caused by the movement system of the time – the horse. Within five years the unhealthy cites of the early 20th cities were transformed into the wonderful places to live that allowed our American lifestyle to prosper for over 100 years.

Automated parking began as early as 1905 in Paris, France. At the time this city had the most cars for any urban environment, while in the United States we already had thousands of parking garages. The French understood that the city needed to park cars densely so that the urban fabric could remain intact. This ground breaking project - Garage Rue de Ponthieu by Auguste Perret set the standard for concrete construction and the internal structural organization of automated parking structures that we still see today for many automated systems constructed around the world.

In the United States, during the 1920's several automated systems appeared in Los Angeles, Chicago, New York and Cincinnati. Some of these systems; 15+ stories, from the 1920's are still standing today. The Ruth Safety Garage in Chicago found within the center of the Jewelers Building now known as the Pure Oil Building is no longer in use, but is still intact. One of the Kent Automatic Parking Garages in New York, now known as the Sofia Apartments, is an Art Deco landmark converted into luxury condominiums in 1983. An automated system that is now found all over Japan – the "ferris-wheel" or paternoster system was created by the Westinghouse Corporation in 1923 and subsequently built in Chicago, 1932, on Monroe Street. The Nash Motor Company created the first glass enclosed version of this system for the Chicago Century of Progress Exhibition and was the precursor to its more recent version; the Smart Car Towers in Europe.

Automated parking was the popular solution in the 1950s when many small towns and large cities embraced the technology to maintain their urban fabric while accommodating the surging number of automobiles and competing with the growing suburban automobile lifestyle. The most popular systems were the Bowser and the Pigeon Hole with over 74 constructed by 1957. Some are still in operation today, such as in New York City. After this brief burst of automated parking, it was rarely constructed in the United States, however became the method of choice in Asia with 1.6 million automated spaces currently in Japan.

Automated parking is now seeing resurgence in Europe and the United States however currently only found when required to meet parking requirements and restrictive site conditions. But, it has a great deal more to offer in creating walkable communities and in meeting financial and environmental goals. More and more

communities are being designed and built to be walkable, and many people embracing this new lifestyle still want and need to own a car so the dilemma of where to park still exists. Parking lots and ramp garages spread out the buildings and are counterproductive to creating walkable communities; only underground and automated parking can relieve this conundrum. Underground garages are the most expensive choice, typically costing over $50,000 a space.

Automated parking is being chosen for financial and design reasons. The owner of the Pallisades, Encore Development, a recent mixed-use development in Towson, MD stated that the cost of automated parking was "competitive if not less" than ramp parking. The structure was formed of concrete that also served as support for the building's green roof and swimming pool above, no mechanical ventilation or lighting was required with 60% greater efficient use of parking space. Given the total design solution it was 25-30% less expensive than if all ramp parking had been chosen. The designer, The Architects Collaborative, saw this as a unique opportunity to create energy efficient parking while stepping out of traditional housing concepts, also using proven technology. This one project, the largest automated parking structure in the United States, also has its greatest benefits to the environment. It reduces air pollution: VOC's reduced by 68%, carbon monoxide by 77%, nitrogen oxides by 81%, carbon dioxide by 83% and fuel savings of 83% when comparing a ramp to the automated facility of 350 spaces.

This paper will discuss how new automobiles and automated parking can address many environmental issues from financial, to land use, along with air quality and architecturally sustainable design.

Cars, Parking and Sustainability

It is hard to imagine since the transformation has been so positive, dramatic and quick, but less than 100 years ago in the United States we had the unhealthiest densest urban areas in the world with disease and death rampant due to transportation dependent upon the horse. But we were also at the lead of the technological curve of transit and automobile design with the French stating in 1898:

> " New York has no motor vehicle exhibition such as recently drew all of Paris to its doors, nor does she as yet count the motor vehicles in her streets by thousands, but she has something which even Paris cannot boast – a complete electric cab installation"(1)

The car was the environmental savior of our early 20th century cities allowing our country to grow and thrive. Within five years the unhealthy cities of the early 20th century were transformed into the wonderful places to live that allowed our American lifestyle to prosper for over 100 years. Today, combining the words cars, parking and sustainability is now considered by many a contradiction in terms.

Two key issues related to cars and parking that effect our environment are emissions and other pollutants from the vehicle itself and the space required for a parked/congested vehicle that physically separates us in our urban design, creates heat islands, light pollution and water run-off issues. Both of these broad areas affect sustainability from two different perspectives. One is an issue with toxins in our environment and the other with our lifestyle - how we live, work and play in the modern world. Many of the sustainable solutions that we can promote today as good for our environment, beyond the electric vehicle, have been explored, designed and built for over 100 years as part of parking garages including automated parking garages, green roofs, solar powered facilities, links with transit and bicycle garages and active walkable street friendly mixed-use living environments.

Within the sustainable design world of the USGBC (United States Green Building Council) LEED (Leadership in Energy and Environmental Design) framework of standards and points, the car is seen as something to minimize while advocating the construction of new buildings where transit exists, building new transit and designing walkable and bicycle friendly places. (2) Environmental toxins and heat, light and water pollution are also addressed with sustainable approaches within LEED. LEED also covers the design, construction and operations of buildings from homes to neighborhoods. While the very specific urban design solutions addressed in LEED are applicable for many areas of our country and for some new developments, the car is still the most versatile form of transportation for many and has the opportunity to participate in creating long-term sustainable solutions for its use, however in LEED the automobile is only addressed when part of a mixed-use or larger urban design. But, it can contribute far more.

Technology led the way to creating healthier sustainable solutions and has been perceived as fulfilling that role during the 20th century. From the late 1800's into the early 1900's many new technologies were being explored that could serve the growing urban populations around the world and also eliminate the hazards of the horse. The elevator led the way, turntable, moving walk, urban transit, automated parking and a moving platform that went through buildings quickly followed, however not ultimately integrated into our daily lives until the second half of the 20th century. Automobiles during the 20th century also continued technological exploration with the electric vehicle and bicycle parking appearing again during the oil and gas crisis of the 1970's. Self-parking and fold-up cars appeared in 1927 with the fold-up bicycle patented in 1955 still being used today. (3) Hovercraft, hybrid power, fuel-cells and hydrogen power all have a long history of innovation. Even as the car continues to be reinvented with the MIT city car and the Segway city vehicle, powering the car with something other than gasoline is understood to be an appropriate solution for many applications. The collapsibility and smaller size of these new prototype vehicles address the issue of space for the car at rest; however the automated parking garage has been doing this for years all around the world; densely parking vehicles allowing less than half the amount of space for the same amount of cars. Today, we are not only bringing these new technologies into our real world and daily lives for long term sustainable solutions but we are integrating "low tech" solutions such as walking and biking into our urban designs to address both issues of toxins and lifestyle for a more sustainable future.

Cars are now moving in the direction of becoming good for the environment again – going back to their electric roots. A large number of vehicles pre 1910 were electric vehicles, with the cab industry, The Electric Vehicle Company leading the way. (4) There were numerous parking garages that provided electric charging stations such as the Edison Electric Garage in Boston, MA, 1913. (5)(Figure 1 and 2) Pittsburgh and Allegheny County Pennsylvania was the epicenter for electric parking stations in 1900 with multiple stations planned and constructed by the Seely Manufacturing Company. (6) Coin operated charging stations were tested in 1899 with over 30 charging stations in northern New Jersey by 1902. (7) Henry Ford's personal parking garage even had electric charging stations for his electric vehicles.

Figure 1: Edison Electric Garage, Boston, MA

Source: "The Edison Electric Garage, Boston, Mass., "Horseless Age 31, no 19 (May7, 1913):841-842.

As we face the compounding issues of air pollution caused by the gasoline powered engine we can now see the positive aspects of an electric vehicle for serving the majority of our daily commuter travel distances even in less densely populated areas. Especially with each family now owning two and three cars – not all vehicles need to be family size! The electric vehicle is perfect for shorter travel distances and can be charged while at work or at home in the evening – the perfect commuter car. The electric vehicle allows the car energy to be clean and transfer the energy source to the power grid that ultimately has many options for sustainable power sources.

Figure 2: Electric Charging Station: Edison Electric Garage

Source: "The Edison Electric Garage, Boston, Mass., "Horseless Age 31, no 19 (May7, 1913):841-842.

The parking garage as the built structure for automobiles becomes the focus for addressing the live, work play aspect of sustainability. The first commercial parking garage in the United States was for an electric vehicle – a cab in 1897 in New York City. Automated parking garages also appeared around 1905. (8) Throughout its built history this building type has explored many solutions that can now be understood as part of sustainable approaches for many building types within the urban fabric, with the green roof first constructed by Theodore Osmundson, a California landscape architect in 1961 and developed on parking structures. (9) The green roof reduces the heat island affect and. light and water pollution can also be addressed to LEED standards with various strategies. However, the most synergistic approach to sustainability is the automated parking garage along with these other strategies.

Elevators and a car "jockey" typically moved the car vertically in a parking garage well into the 1920's when ramps started to appear. But, by using a system of elevators, turntables and sliding trays, the first automatic parking garages came into existence. As the automated parking garage evolved through the 20th century it became a full machine run by a computer that with a swipe of a card takes your car, parks it automatically and returns it to you upon request now called an AVSRS (Automatic Vehicle Storage and Retrieval System).

Automated parking began in 1905 in Paris, France. At the time this city had the most cars for any urban environment, while in the United States we already had thousands of parking garages for all of our cars. The French understood that the city needed to park cars densely so that the urban fabric could remain intact and a fully automated parking garage accomplished this. The ground breaking project - Garage Rue de Ponthieu by Auguste Perret set the standard for concrete construction and the internal structural organization of automated parking structures that we still see today for many automated systems constructed around the world. (10)(Figure 3) The basic structure is parking automobiles two cars deep bumper to bumper, on either side of a multi-story open shaft space that houses a device (many different types currently exist) to move the parked vehicle into its parking slot without the assistance of humans.

Figure 3: Garage Rue de Ponthieu by Auguste Perret, Paris France, 1905
Source: Robert Mallet-Stevens and Jacques Roederer, "Notes from Paris," *Architectural Review* 24 (September 1908):136-138.

In the 1920's, other types of automated systems were designed and constructed such as the "ferris-wheel" design that is the staple of Japanese automated parking today. This system is called a paternoster in Germany and is just like a ferris-wheel except for cars. The system can be located within buildings requiring little space to park multiple cars if the parking demand is not too great. J.E. Morton invented this device in the United States, 1923, but Westinghouse actually constructed the first commercial systems in Chicago on Monroe Street. (11) (Figure 4) The Nash Motor Company created the first glass enclosed version of this system for the Chicago Century of Progress

Exhibition,1933 and was the precursor to its more recent version; the Smart Car Tower in Europe.

Figure 4: Ferris-wheel type automatic parking machine, 1920's
Source: "Eight Cars Housed on Ground Space Formally Required by Two," *Electric Journal* 26, no 10 (October 1929): 479.

In the United States, during the 1920's several automated parking garages appeared in Los Angeles, Chicago, New York and Cincinnati. Some of these systems; 15-27 stories are still standing today. (Figure 5) The Ruth Safety Garage in Chicago found within the center of the Jewelers Building now known as the Pure Oil Building is no longer in use, but is still intact. One of the Kent Automatic Parking Garages in New York, now known as the Sofia Apartments, is an Art Deco landmark converted into luxury condominiums in 1983. (12)

Automated parking was the popular solution in the 1950s when many small towns and large cities embraced the technology to maintain their urban fabric while accommodating the surging number of automobiles and competing with the growing suburban automobile lifestyle. The most popular systems were the Bowser and the Pigeon Hole with over 74 constructed by 1957. Some are still in operation today, such as in New York City and Miami. (13)(Figure 6) After this brief burst of automated parking, it was rarely constructed in the United States, until recently; however became the method of choice in Asia with 1.6 million automated spaces currently in Japan.

Figure 5: Kent Automatic Parking Garage, New York City, 1927
Source: "Kent Automatic Parking Garage, New York," *American Architect* (June 20, 1928): 835-837.

Figure 6: New York 1950's Automatic Parking Garage
Photograph: Shannon Sanders McDonald, AIA

Automated parking is now seeing resurgence in Europe and the United States however currently only found when required to meet parking requirements and restrictive site conditions. But, it has a great deal more to offer in creating walkable communities and in meeting financial and environmental goals. More and more communities are being designed and built to be walkable, and many people embracing this new lifestyle still want and need to own a car so the dilemma of where to park still exists. Parking lots and ramp garages spread out the buildings and are counterproductive to creating walkable communities; only underground and automated parking can relieve this conundrum. AVSRS (Automated Vehicle Storage and Retrieval Systems) as automated parking garages are called today has the greatest efficiency in square ft per stall (approximately 225 sqft compared to 320 sqft in conventional parking structures). (Figures 7 and 8)

Construction Cost Comparisons

	Unit Cost, $ per sf	Efficiency, SF/Stall	Cost Per Stall	Automated Machinery Cost, $/Stall	Total Cost, $/Stall
Ramp Garage, Above Grade	$45	320	$14,400	0	$14,400
Ramp Garage, Under Building, Above Grade	$75	450	$33,750	0	$33,750
Ramp Garage, Under Building, Below Grade	$105	450	$47,250	0	$47,250
Automated Garage, Under Building, Above Grade	$65	225	$14,625	$16,000	$30,625
Automated Garage, Under Building, Below Grade	$85	225	$19,125	$16,000	$35,125

Figure 7: Construction cost comparisons between conventional ramp garages and Automated Garages (Monahan: 2011)

Underground garages are the most expensive choice, typically costing over $50,000 a space, however underground automated parking reduces this cost as excavation costs are reduced by the compact parking method. An AVSRS below grade under a building costs less than a ramp garage under a building and below grade per data compiled by Walker Parking Consultants . In the last 9 years, at least 17 AVSRS parking structures have been completed in the USA with at least another 8 under construction. (14).

Garage Type	# Levels	Length, FT	Width, FT	Floor Area, SF	# Stalls	Efficiency, SF/Stall	Unit Cost, $/SF	Const. Cost, $	Cost per Stall, $
Ramp-Access Garage	4-1/2	182	112	90,272	203	445	$60	$6.0 Million	29,600
Automated Garage	5	144	81	58,217	217	268	$106	$6.2 million	$28,170

Figure 8: Space and cost comparisons between conventional ramp garages and Automated Garages (Monahan: 2011)

Automated parking is also being chosen for financial and design reasons. The owner of the Pallisades, Encore Development, a recent mixed-use development in Towson, MD stated that the cost of automated parking was “competitive if not less” than ramp parking. The structure was formed of concrete that also served as support for the building’s green roof and swimming pool above, no mechanical ventilation or lighting was required with 60% greater efficient use of parking space. Given the total design solution it was 25-30% less expensive than if all ramp parking had been chosen. The ability to literally double, triple or quadruple the parking capacity of any area provides for an increase in revenue. On projects the reduced parking area provides the opportunity to increase residential, commercial or retail spaces that will add revenue. The designer, The Architects Collaborative, saw this as a unique opportunity to create energy efficient parking while stepping out of traditional housing concepts, while using proven technology and adding residential units.

Automated parking garages can also assist with the toxic environmental issues since the automobile is not moving once it enters the automated garage. The Pallisades Project, the largest automated parking structure in the United States with 410 spaces, also has its greatest benefits to the environment. It reduces air pollution: VOC’s reduced by 68%, carbon monoxide by 77%, nitrogen oxides by 81%, carbon dioxide by 83% and fuel savings of 83% when comparing a ramp to the automated facility of 350 spaces. These are astounding and impressive results that support a reduced carbon footprint provided by AVSRS parking structures. The impact on air pollution was determined by scientifically accepted models as referred to by EEA Consultants, Inc (an Environmental Engineering firm). Vehicle emission factors (in grams of pollutant per vehicle-mile or per hour of idling) and fuel use (mpg) for an analysis year of 2008 were determined using the USEPA’s MOBILE6.2 mobile source emissions model, based on travel speed, vehicle classification, and engine thermal conditions. The speed within the garage was assumed to be 5mph. (15)

One of the key advantages of AVSRS is the ability to reduce air pollution: these systems save up to 83 percent in vehicle fuel emissions compared to conventional parking facilities, since vehicles are not running in the garage and drivers are not circulating within the structure searching for available parking spaces or returning to the exit from multiple levels. (16) Drivers leave their vehicles in the Transfer Stations with the ignition off, and the robotic equipment transports and stores the vehicle in the unoccupied storage vault until the vehicle is retrieved at a later time. The amount of volatile gasses saved by a 200 vehicle system is equal to removing 92 cars off the roads each year or planting 67,000 trees. If the entire parking facility has been designed and constructed as a net-zero energy project and has been energy neutral for over a period of one year, these numbers increase to: 115 cars off the road each year, or planting 85,000 trees. (17)

Lighting, heating and cooling is also not required due to the fact that very few people enter the area of parked vehicles, although in extreme conditions it may be necessary to keep the volume and surfaces above freezing so as not to damage normal operation of the equipment. Reduced ventilation is required for enclosed AVSRS parking structures although only a minimum of two air changes per hour is required compared to up to twelve in conventional underground or closed parking facilities. Energy consumption is therefore greatly reduced as an automated parking facility due to its limited use.

Again, although AVSRS parking structure equipment is electro-mechanical and consumes energy for the operation of the robotic storage and retrieval devices, these are only active for the time of storage and/or retrieval processing, allowing the system to hibernate or become dormant when not in use. Typically an AVSRS parking system uses between 0.3 and 0.5 kWh per combined park and retrieve cycle. The cost of a unit of electricity in NYC in 2008 and 2009 was between $0.15 and $0.29 per unit: this equates to a cost of between $0.10 to $0.15 per park/retrieve cycle - using the highest electricity cost/kWh In general terns this equates to burning a 100Watt light bulb for 3 to 5 hours or using a hair dryer for 20 min. (Electricity Cost Calculator http://www.handymath.com/cgi-bin/electric.cgi) (18)

One of the most important aspects to automated parking is that the amount of land consumed for parking is greatly reduced. (Figure 9) Parking garages tend to spread buildings apart creating greater distances and less desirability to walk while also leaving large uncomfortable lightly populated area. Underground parking and AVSRS facilities are the most direct way to minimize this sprawl affect allowing for healthy and vibrant communities that can include the automobile. Once your car is dropped off at the entry area, you can then directly access a well-designed active street environment.

Figure 9: Lincoln, NE and growth of parking garages on a typical city block
Shannon Sanders McDonald, Visiting Professor University of Nebraska, Lincoln, 2002, student work.

When considering the benefits of AVSRS parking structures, it is apparent that this form of technological advancement is fundamental from a sustainability standpoint in creating parking accessible to people, our living places and the environment in the search for best architectural solutions for the location, site and program and in developing long term sustainable choices for our environment. (19)

Of great concern is that parking is one of the single largest land-uses in urban areas in the United States, and this greatly impacts on this building type's ability to become sustainable. US zoning codes typically require a minimum of parking spaces based on a building's intended use. This creates an oversupply of parking spaces as based upon the Nationwide Household Transportation Survey data, people ages 25-54 make an average of 4.5 trips a day, although every trip does not require a parking space, this is the best data for the United States that we have at this time. Statistics show that parking spaces out-number vehicles *at minimum* 3 to 1 (20), which currently equates to over 500 million empty parking spaces at any one time, and frequently referenced at 5 to 1 and even 8 to 1.

AVSRS parking structures require less land for the same number of parked cars. This can create the opportunity to create more urban open space which can contribute to a greater sense of community when the open spaces include parks, recreation activities and public plazas. Public spaces are used to link activities, provide gathering spaces and allow for enhanced social interaction and improved sense of community, so their importance over large underutilized structures is very important when considering the urban fabric and how we use limited space. An example of this is a residential project in Copenhagen which incorporated two 700-car towers with a public garden and skate park between them, as well as interior community waiting areas for all of the residents acting as the gathering informational spot. (21)

Integration of AVSRS parking structures into existing and historic streetscapes is one of the major benefits of the parking approach. The smaller area required, flat floor plates allow the facades to match the existing urban appearance. Bohl Architects added 18 underground AVSRS spaces into an office/retail project in historic downtown Annapolis, MD (2009) while allowing the design of the new building to fit in the minimal space of its predecessor. This design maintained the historic fabric of the city while achieving additional parking with just a small well designed entry area for the vehicle to be transferred to the parking area below the building. (22) (Figure 10)

Figure 10: Annapolis, MD, Bohl Architects, infill project with automated underground parking, 2009. Courtesy: Bohl Architects

Cost incentives for automated facilities are in the form of reduced security, reduced utilities, reduced liability, reduced insurance, and reduced damage and loss of property. Since, an AVSRS parking structures consist of mechanical devices, there is an economic benefit in the form of accelerated depreciation: this is an annual tax deduction that allows recovery of costs over the expected useful life-cycle period of the equipment. AVSRS parking structure equipment would qualify for accelerated depreciation, thereby reinforcing this parking facility-type's ability to be economically viable.

Tax Incentives are also being offered for projects that meet sustainability goals; many projects are seeking areas of design that contribute towards achieving sustainability standards, and AVSRS parking structures help to provide innovations in design for reduced spatial requirements, reduced carbon emissions, and providing local limited parking capacities with managed storage areas for no additional parking.

Thinking of parking as a machine is in the United States a new process, but by examining how many sustainable aspects can be contributed by utilizing these new technologies, this parking solution can be appropriate and the best choice in many situations. While, it cannot compete in cost to a stand-alone conventional garage where land is not a major concern the AVSRS parking structure has many applications and contributions to sustainability that can encourage walkable design, sustainability and still allow for personal automobile use. Even in underground applications the AVSRS can most frequently be the best choice for long term sustainability.

Notes

1.”Our Electric Cab Station,” Horseless Age 3, no 6 (September 1898):1.
2. Welcome to USGBC, accessed February 20, 2012, http://www.usgbc.org/
3. Shannon McDonald, *The Parking Garage: Design and Evolution of a Modern Urban Form* (Washington, DC: Urban Land Institute, 2007), 263.
4. Ibid., 15.
5. Ibid.,16.
6. Ibid.,16.
7. Ibid.,16.
8. Ibid.,110.
9. Ibid.,255.
10. Ibid.,110.
11. Ibid.,116-117.
12 Ibid.,112.
13. Ibid.,122-126.
14. Don Monahan, Presentation at UCLA Zinman Center for Real Estate, Automated Parking Structures Symposium,” The Parking Dilemma: Innovative solutions for High Density Parking and Automated Vehicle Storage,” October 13, 2011, access web site for links to presentations, http://www.anderson.ucla.edu/x37321.xml.
15. Samuel I. Schwartz, “The Garage of the Future Must Be Green,” *NPA Parking Magazine*, March 2009: 32-36.
16. Samuel I. Schwartz, “The Garage of the Future Must Be Green,” *NPA Parking Magazine*, March 2009: 32-36.
17. Arup Engineering, Los Angeles (2009). AVSRS Parking Structure vs Conventional Parking Structure, Data-sheet/presentation.
18. Ryan Astrop, Information shared about New York Automated Parking Garage Project while working on a upcoming jointly authored book chapter, 2011.
19. Charlie Munn, “Past Hoboken: AVSRS Parking Facilities – Enter Hopeful New Era, “ *NPA Parking Magazine*, March 2009:24-28.
20. Jasmin Malik Chua, “ Parking Spaces Outnumber Cars 3 to 1, Cause Environmental Problems” web site accessed February 21, 2012, http://www.treehugger.com/cars/parking-spaces-outnumber-cars-3-to-1-cause-environmental-problems.html
21. Shannon McDonald, *The Parking Garage: Design and Evolution of a Modern Urban Form* (Washington, DC: Urban Land Institute, 2007), 262.
22. Ibid.,132.

References

Arup Engineering. “AVSRS Parking Structure vs Conventional Parking Structure.” Los Angeles, 2009. Data-sheet/presentation.

Chua, Jasmin Malik. Parking Spaces Outnumber Cars 3 to 1, Cause Environmental Problems http://www.treehugger.com/cars/parking-spaces-outnumber-cars-3-to-1-cause-environmental-problems.html. 2007.

McDonald, Shannon Sanders. *The Parking Garage: Design and Evolution of a Modern Urban Form*: Urban Land Institute, 2007.

McDonald, Shannon . “ AVSRS Parking Saves Space in Tight Places.” In Transition Magazine, http://www.intransitionmag.org/SpringSummer_2010/AVSRS_parking.aspx. 2007.

Monahan, Don. “Status of Automated Vehicle Storage Systems in the U.S.”, Parking Today, January 2010:20,22.

Munn, Charlie (2009) Past Hoboken: AVSRS Parking Facilities – Enter Hopeful New Era. NPA Parking Magazine. March 2009: 24-28.

Schwartz, Samuel I. “The Garage of the Future Must Be Green”. NPA Parking Magazine, March, 2009: 32-36.

Shoup, Donald . “The High Cost of Free Parking”. American Planning Association, 2005.