AIA ILLINOIS CONFERENCE

Title: Sustainable Designs for Emerging Energy and Movement Technologies

Track: The Profession of Architecture/Emerging Professionals Trends

Program Summary:
New movement technologies such as the NEV (Neighborhood Electric Vehicle), electric vehicles, segways, PRT (Personal Rapid Transit), bicycles and three-dimensional elevators are changing the ways that we can move in space. How we move, communicate and where we park are the formative aspects of design change and we are in the midst of “massive change”. A brief history of the automobile and the parking garage that has its roots in the electric vehicle, sustainability and innovation will be presented. Amazing new projects such as Mazdar City and other new research that are creating carbon neutral environments with these new movement technologies due to innovation and collaboration with many other disciplines will be presented.

Program Abstract:
Integrating the automobile at rest is always a challenging problem, linking it with transit, and other environmental solutions along with other building typologies to create active vital mixed use environments presents even more sustainable possibilities. The early years of parking garage design from 1897 well into the 1940’s, long overlooked, had a great deal to show us in seeking new solutions as the parking facility was considered a public building typology. Designs of early parking facilities were beautiful and beautifully integrated into the urban fabric even within small scale environments and many are currently adaptively re-used. This program will explain why some of these strategies worked and how they can be adapted for modern use.

The very first parking facility was for electric vehicles and we Americans were considered by the French as the cutting edge of technological design. So, as the parking facility is now is going back to its environmental roots - what are the new technologies and synergies that are emerging – all of these will be discussed in great detail. Integrating these technologies within existing neighborhoods and within historic fabric also poses other design challenges. Design solutions to all of these situations will be addressed.

New ways to view, experience, and think about these often ignored structures will open up your imagination as you see a new way to look at the 20th century. Just a change in how you think about parking facilities by seeing these unique solutions, inside and out, will allow your design ideas to start to flow and new synergies and solutions to emerge as new movement technologies are now coming into the market that can transform design.

The parking garage was and is still the place of innovation for new technologies. As the car starts to change and new advanced transit technologies are now becoming reality all around the world how they impact design of not only the parking garage, but our buildings, cities and towns will also be explored.

Learning Objectives and New Knowledge and Skills:
1. Participants will be able to identify multiple strategies that allow the parking facility to better integrate into the urban fabric and mixed-use projects.
2. Participants will be able to list new strategies that are transforming parking facility design into more environmentally and people friendly environments.
3. Participants will develop new visions of how parking can be designed to complement rather than detract from urban and architectural design and to provide better environments for people.
**New Knowledge:**
1. To identify new “movement” technologies that will positively impact how we design our buildings and urban environment.
2. To learn about current research and development that we will be integrating into our built world that can create carbon neutral places and spaces.
3. To examine current projects that are implementing these new movement concepts becoming carbon neutral -- such as Mazdar City.
4. To imagine and brainstorm other ideas on how these new technologies can improve our built environment and our lives.

**Program Format and Length:** 90 minute Presentation, Interaction and Questions

**Credit/COTE Top Ten Measures:**
This will be eligible for sustainable design credit.
Design and Innovation, Regional and Community Design and Energy Flows and Energy Future

**Experience Level:** Appropriate for all Levels
Sustainable Design for Emerging Energy and Movement Technologies”
“Collaboration / Innovation”

Paper

New movement technologies are at the core of architectural and planning design change. The 20th century is an example of such change in our built world due to the car and its required building type -- the parking garage or ubiquitous parking lot. At that time, American cities were places of disease due to the prevalent movement system of choice – the horse. (Image 1) New York City also had the densest population area in the world; new movement technologies changed all of this – the parking garage was the building type that represented the car – the environmental savior of the modern city. As engineering, energy and their related technologies advance, their impact is directly felt in all the design professions; while the impact may not be studied or fully understood before the technology is implemented. The advances in movement devices that allow us to move differently through our environment have far reaching abilities to change our built environment for the better providing greater access for all. Again, we are in the midst of such a change and need to take the opportunity to see how the built world can be designed to best utilize these newly emerging movement technologies. Sometimes their impact is simultaneous and massive, while at other times it is only incremental. For example the electric vehicle may only promote incremental change while the Personal Rapid Transit (PRT) and Smart City Cars by MIT Media Lab may evoke massive change.

We are currently experiencing both incremental and massive change in how we move in and through our built world. The new movement technologies combined with changes in our fuel sources and further advances in computer technology will combine to create massive change. Currently, incremental change can be found with the new devices such as Neighborhood Electric Vehicles (NEV) (small low speed vehicles) and electric vehicles as they can still conform to our existing urban environment, roads and streets with minor change. While segways and their related small car, small personal movement devices, provide an entirely new way to travel that could provoke changes in our larger built environment as they are now driven inside buildings as well as within the existing urban fabric of sidewalks and streets. (Image 2) The overall change to smaller and smaller movement devices and those that are not powered by gasoline will eventually impact the design of the interiors of our buildings. However, other technologies, such as (PRT) combining with the advances in computer systems, such as fuzzy logic, can promote even larger scale changes that will impact architectural and urban design allowing for new organizations of entire communities potentially eliminating cars entirely. While the technology exists for the three-dimensional elevator (an elevator that can move both vertically and horizontally) and a prototype has been constructed, as of yet none have been implemented in our living environment. This elevator system, also driven by fuzzy logic, has the potential within a community to also potentially eliminate the car while still providing people access within a given range.

Masdar City, Abu Dhabi, United Arab Emirates is one of the first new towns to be constructed implementing some of these new movement ideas, renewable energy and clean technologies. PRT linking to light rail, heavy rail and automobile access are the key movement devices mainly in the undercroft of the new city. This completely new city structure is designed for the main surface level of the city to be car free and pedestrian friendly. Masdar City is also the first
city to attempt to be carbon-free and net-zero energy. However, some cars still arrive and are owned by people in the city. They are to be parked in multiple, massive parking structures at the edges of the city. (Image 3) This parking garage location concept originates with Louis Kahn and his plan for Philadelphia to defend the city from the car by surrounding it with parking structures that also housed residential units. Philadelphia would be a walking city from these edges. This idea was rejected by Edmond Bacon, the Philadelphia city planner as he believed that for a city to remain vital all aspects of movement needed to have complete access to the city center. (Image 4) So, even with the best attempts to create car free pedestrian friendly environments the car is typically not removed completely as a transportation device in modern urban design and we are seeing this trend around the world as wealth increases in India and China.

Integrating these new movement technologies within existing neighborhoods and within historic fabrics also provides new design opportunities, in that many of these new technologies can actually assist with maintaining the historic fabric. Smaller, environmentally friendly movement devices that have greater flexibility of movement path can allow historic fabrics to remain if that potential is understood. While, three dimensional elevator systems can assist with the interior of buildings as now the single elevator shaft can be replaced by a multi- directional shaft potentially saving and protecting key architectural spaces.

The bicycle is also seeing resurgence in urban planning strategies as an alternative to the car. For example bike sharing programs such as one in Washington, DC, capital bike share, is on its way to becoming a success in the city. (Image 5) However, the bicycle also has its limitations of time, weather and access due to accessibility issues. Also, when used in great numbers, such as in Japan, they require large multi-story structures for parking the quantity of vehicles that cluster at transit stations and other large venues. (Image 6) So, although smaller and compact and environmentally friendly they follow a similar land use pattern to the car in dense urban areas.

The parking garage was and is still the physical place of innovation for the many new technologies of the 20th century: double-tee, green roofs and electric vehicles to name a few. The very first parking facility was for electric vehicles in New York City for an electric cab company. (Image 7) The French considered us 1897 as at the cutting edge of technological design with an electric cab installation.

"New York has no motor vehicle exhibition such as recently drew all of Paris to its doors, or does as of yet count the number of motor vehicles in her streets by the thousands, but she has something which even Paris, the mother of the motor vehicle, cannot boast – a complete electric cab installation."

The French at this time were at the leading edge of movement technologies with the inclined elevator in the Eiffel Tower and the moving walks at the Paris Exposition of 1900. (Image 8) The majority of vehicles before 1910 were electric vehicles and coin-operated electric charging stations could be found on our streets as early as 1900. One in Long Island, was privately owned by a Doctor, but placed in his front yard on the street edge for public use. The parking facility is now is going back to its environmental and technological roots and new synergies are emerging for design and for our urban fabric.
The early years of parking garage design from 1897 well into the 1940’s, long overlooked, has a great deal to show us in seeking new solutions. The parking facility was considered a public building typology and a great deal of attention was focused on its design. It was a building type that many now-famous modern architects and engineers were exploring such as Frank Lloyd Wright, Albert Kahn, and Holabird and Roche (a forerunner to Holabird and Root). It was designed completely differently than the typical parking garages of today. Early parking facilities were beautiful buildings and appropriately integrated into the urban fabric even within pedestrian scale environments. *(Image 9)* Many of these early parking structures are currently adaptively re-used with people who inhabit these building every day not aware that they are living or working in a former parking structure. For example the Grand Avenue Garage, an elevator garage currently a condo in Los Angles. *(Image 10)*

Collaboration/innovation in the early years of parking garage design was the key. Engineers and architects were working singly and together to determine how to house the exponentially growing number of cars. By 1905 thousands of parking garages existed looking very similar to buildings of the period. Cars required heat and cover as it was not until the 1930’s that they could withstand the elements to be parked on the street (start of parking meter) or in open air garages. Parking garages were often mixed-use such as the Chicago Automobile Club, 1907, where a parking garage, hotel, shopping, conference and ballroom spaces were included in one beautiful structure. *(Image 11)* Many of the early parking structures maintained small shops on the street level fully integrating them into the urban fabric.

However, it was long span construction that was required for efficient parking and that is where a great deal of innovation in design occurred. From the study of reinforced concrete by MIT Professor Lanza, to the invention of TY Lins’ single tee and the double tee of Harry Edwards, the parking garage became due to the quantity of cars parked and that related required size to accommodate them the most prominent building on a block, consuming whole blocks and then defining new block sizes in the urban plan. The Moto Mart Garage in Boston, 1905 was one of the earliest examples to fill an entire block. *(Image 12)* Developing fire codes especially with the mixed-use structures was another key area for study, as many building codes are based on early research and studies of parking structures. Their location in the city was determined by these codes as well their fireproof material and sprinklers were required.

The early parking structures used elevator technology to move cars vertically through the building as the ramp was not prevalent until the late 1920’s. Ramp design was a major area of study and many ramp configurations evolved during this period. The first ramp was constructed for a New York Taxicab Company, 1909, so that many cabs could quickly access the street almost simultaneously. *(Image 13)* Designing and constructing curved concrete ramps sloped in multiple dimensions was an amazing evolution all of its own started by Holabird and Roche of Chicago around 1917. Albert Kahn and others in the mid 1920’s realized that parking could occur on a single curved ramp and these structures were built. *(Image 14)* The double spiral helix allowing for separate up and down traffic within one spiral was explored by Frank Lloyd Wright in the Sugarloaf Mountain Project. Maryland in 1924, however never constructed. His design also provided separate pedestrian paths. *(Image 15)*

By 1915, the need for parking was so intense in the downtown of Chicago that the current Grant Park was a sea of parking and an underground garage was proposed for the area, but
mechanical systems for ventilation were in their infancy. (Image 16) By the 1940’s underground structures actually appeared in many cities first in San Francisco as the many issues related to mechanical ventilation to provide fresh air into these spaces was advancing. (Image 17) It was only through the overlap of many disciplines that advances in the car and the parking garage occurred. This type of synergy is occurring again today and will only increase as our movement systems continue to evolve.

Mechanization and technology was at the heart of all of these design changes creating a wonderful healthy clean lifestyle for modern society. The height of mechanization was the automated parking garage. The first one in Paris, France, 1905 designed by Auguste Perrett called the Rue de Ponthieu. (Image 18) Chicago was again at the center of these emerging technologies in the 1920’s with the Westinghouse designed ferris wheel system, 1921, subsequently applied to the Nash Motor Car Company, Century of Progress Exposition exhibit, 1933. (Image 19) One 1920’s example, the Jewelers Building in Chicago, IL still exists today, The Ruth Safety Garage in the Jewelers building. (Image 20) Several 20+ story mechanized parking towers were constructed across the country in the 1920’s and many remain now as multistory housing such as the Sofia Apartments in New York City. In the United States during the 1950’s a reemergence of new automated parking technologies occurred with many systems appearing, the earliest was the Bowser System first constructed in Des Moines, Iowa. (Image 21) These systems were built around the country and world, however it was only in the now denser Asian countries that automated parking garages became the norm rather than the exception, due to land use patterns. We are now seeing a resurgence of automated parking facilities in Europe and the United States.

Other movement technologies also started by linking with the parking garage. Moving walkways also were first proposed to connect parking to the downtown buildings in 1954 Jersey City, NJ. (Image 22) But, they eventually became the norm for large airports within buildings. Electric vehicles reappeared in the oil and gas crisis of the 1970’s and some parking garages provided the charging stations for their use. (Image 23) Free bicycle parking was also encouraged during this period in Downtown Washington DC parking garages and some others across the country. (Image 24) Hopefully, we are now implementing what we learned during the 1970’s period and are now seriously implementing all of the changes to urban and architectural design to address these interrelated and complex issues.

Perhaps the most promising new technology that will bring about massive change is the PRT system. The 1970’s vision of modern transit technology as seen in Paul Rudolph, Ulrich Franzen and Victor Gruen studies is currently becoming reality around the world. (Image 25) Computer technology is allowing this paradigm changing movement technology to implement its original vision. PRT (Personal Rapid Transit) now sometimes called ATN (Automated Transit Network) is currently available at Schiphol Airport in Amsterdam, Heathrow airport and Masdar City with systems in various planning stages in Suncheon City, South Korea; San Jose, CA -Sam Mineta Airport and India - with studies for multiple other locations. (Image 26) PRT provides the opportunity to create walkable transit friendly environments by allowing more compact and interconnected ways to move through space due to its small size and new transit moment paradigm – point to point – providing service similar to a cab. This technology has the ability to move more people faster to their destination – even more time-efficient than a car and more time-efficient than the standard transit loop or line systems; therefore they can encourage and hopefully increase transit use.
This technology offers another important design feature – its ability to interface three-dimensionally both inside and outside of buildings. This capability allows for many right-of-way issues to be approached in various ways especially in existing urban fabrics by providing choices both on the ground and with air-rights. PRT can link multiple transit and automobile systems and connect with sustainable energy sources changing transportations’ relationship with urban design and architecture. New integrated solutions that address multiple overlapping issues such as energy sources, the environment and persons of disability can now be easily addressed due to its small size and relative scale. PRT provides a lower cost and better energy use as documented for the modern Heathrow system. (Figure 1) There are many benefits for the application of PRT in our built world such as more affordable land use patterns, cost effective transit, ability to connect all current forms of movement, ability to be constructed in existing and historical environments, simultaneously used as a freight application and cost-effective interconnected station design.

Integrating a new way to move through space is a more sustainable solution that allows for stations within easy walking distance encouraging walking. Initially these systems are being implemented in two areas – local existing environments such as airports and entirely new cities, with potential at other large complexes such as hospitals and universities. Also, multiple studies are underway around the world for implementation into existing cities and towns. Students studied the implementation of a PRT system at Southern Polytechnic University in Marietta, GA to address the accessibility issues on the campus. (Figure 2)

PRT was first implemented in the United States at Morgantown, West Virginia at West Virginia University using a 25 person capacity (now known as group rapid transit) point-to-point driverless vehicles (a system where you go directly from your point of origin to your final destination – no stops in between) called PRT. The dedicated elevated track system is still functioning today providing unique transportation choices for the university and the town and is in the process of studying expansion. Although at the time due to its groundbreaking nature the system was developed with extensive cost overruns slowing the further development of this paradigm changing movement technology. (Image 28)

This newly emerging movement system will allow easier access for all ages as station design can now be integrated within buildings at multiple levels. Navigating steep topography and dealing with poor weather as well as connecting multiple other forms of transit to create a seamless system will allow faster and smoother access for all. Also, many small stations will not affect the transit time for the users as it is a destination based system. Linking spaces and places in entirely new ways, the architects’ unique spatial training will become essential in allowing this new technology to be implemented to its full potential.

There is a direct relationship in the ability to move around our built environment in a timely, accessible, and sustainable way and to the success of that living environment. Providing choices and options for each user can create the greatest success in achieving this goal. Finding long term sustainable energy, environmental, planning and financial solutions that can work for all and across our diverse country is difficult especially if depending on one form of movement – the car. Relying on the private car fueled by gasoline also poses the issues of parking and roads that spread out the distances between buildings in villages, towns and cities. Motorcycle extends this distance even further. The car can now come in various sizes such as the electric cart all the way to the largest delivery vehicle with various ranges in-between, while transit can involve a bus or trolley to heavy
and light rail. Adding transit brings more cost into the equation while frequently extending travel times due to the combination of travel time of car and transit - discouraging transit use. Walking only is a good option if the community is designed within distances that the user will accept and that also link to multiple flexible transit options, however weather, carrying items, persons of disability and aging population concerns can make this approach not feasible for all. Depending upon each situation all forms of transportation can be found to serve different movement distances and needs. Movement needs are complex and interconnected and PRT can allow for these connections and interconnections to occur. (Figure 3)

Concurrently addressing the full environmental impact adds even more challenges to finding appropriate solutions. Not incidentally the amount of land consumed for parking cars can be at least 54% of the total land area coverage in a typical commercial development as documented in a study by the public works department for the City of Olympia, WA. (Figure 4) Parking for business and housing as well as for multiple other daily needs adds to the complexity for solving full accessibility movement issues as each of us statistically uses 5-8 different spaces a day. Add into the mix the need for delivery and freight in a timely way so that business can prosper and the complexity is overwhelming and the sustainable solutions hard to find. Many focus their research on one or two aspects; however this is starting to change as it is in the combination of the issues where better solutions can be found. Collaboration and Innovation are the key. The architect is trained to balance and resolve the multiple complex issues typically also “customizing” for the specific site, owner and location with training in synthesizing this three-dimensional spatial complexity. However, the architect is frequently consulted only for the purpose of designing the station or to focus on what the built environment “looks like”. While aesthetics is one key concern to an architect, how that evolves is by finding solutions that balance all of the design needs.

For example, a more “natural” approach to pedestrian movement can be established while providing a safe interaction with machines. A more “natural” approach to movement can be described as a networked system. (Figure 5) This networked system opens up new locations for retail, parks and people places that were previously not available within the grid or spoke and wheel organizational patterns for such use. If the networked system allows and encourages multiple spatial overlaps between levels even more possibilities and linkages are created.

New ways to view, experience, and think about these often ignored structures, the parking garage, will open up your imagination as you see a new way to look at the 20th century. Just a change in how you think about parking facilities by seeing these unique solutions, inside and out, will allow your design ideas to start to flow and new synergies and solutions to emerge as new movement technologies are now coming into our world to transform design again. Creating walkable transit friendly environments requires more compact and interconnected ways to connect the movement systems that we have for new design and movement through space and place and is an area ripe for further studies and collaboration. (Images 29-57)
UK Data. Assumptions:
- Average passenger loads
- Well to wheel (darker shading direct electricity use only)

MJoule per Passenger km

Figure 1: Chart showing energy usage and cost comparisons.
ULTra: PRT Sustainable Transport Source: Martin Lowsen of ULTra

Path Distribution for Individuals with Disability

Figure 2: Southern Illinois University analysis of mobility on the campus by Omar Martinez.
Figure 3: Conceptual comparison of modes in the Accessibility – Throughput spectrum from Young, Miller, McDonald. Keys to Innovative Transport Development. Presented at the 87 Annual Meeting of the Transportation Research Board, Washington, D.C., 2007.

Figure 4: City of Olympia Public Works Department and the Washington State Department of Ecology, 1995.
Figure 5: Montana State University student, Matthew Killham abstract visualization of new ways to provide movement linkages, 2001.