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Contents

From the Chair...

by Larry Lennon, P.E., AICP

I'm writing this column from Philadelphia where I'm attending "From Design to Delivery: Planning America's Freight Movement", a conference sponsored by APA, USDOT, the National Association of Regional Councils, the Coalition for America's Gateways & Trade Centers and the Delaware Regional Planning Commission. APA's Peter Hawley was an organizer.

The Conference has examined the connection between land-use and goods movement including the need to balance economic development and quality of life issues in planning freight transportation facilities and operations. Speakers have included planners, operators, regulators, marketers and consumers of these services including APA's Paul Farmer. A conference summary will appear in the next TPD Newsletter.

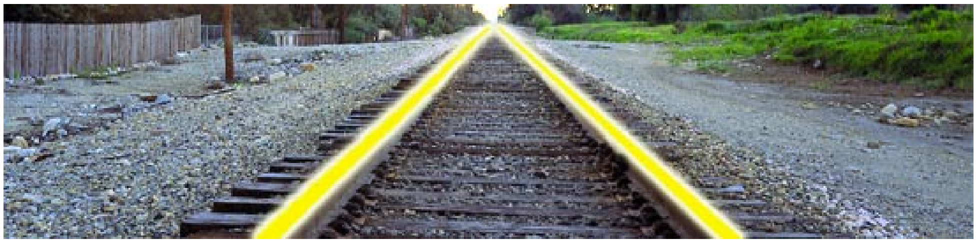
Hurricane Katrina

The economic and personal devastation associated with Hurricane Katrina has become a major focus of APA, and we can all be proud of the assistance provided by APA members to displaced planners and students. Emergency response and reconstruction have been added to the agenda for APA's Fall Leadership conference in Buffalo, NY. Our condolences go out to all the victims of this tragedy and their loved ones.

2006 National Planning Conference

Hilary Perkins, TPD's Vice-Chair, has submitted our two "by-right" sessions for the 2006 National Planning Conference to be held in April in San Antonio.

see "Chair", page 4



A Planner's Guide to Fixed Guideway Electrification Projects

By Stephen A. Gazillo, AICP

Editor's note: We're trying something new in this issue by printing the first half of a longer article on fixed guideway electrification. The last half, which discusses environmental considerations, will be part of our next issue.

This article sets out to highlight some of the major elements of fixed guideway and railroad electrification systems, and to point out what transportation planners should be aware of as they evaluate alternatives for new public transportation projects in their communities. While planners continue to debate the cost effectiveness of rail transit as a force in urban development and land use, in those cases where rail transit is a viable option, electrification inevitably is a factor, whether one is considering streetcars, light rail, heavy-rail, commuter rail or even BRT systems.

Introduction

Perception, attitudes and political support of fixed guideway electrification projects can vary dramatically from one state to another, from one community to the next, and even from one neighbor to another. What is endorsed in one town can be reviled and criticized heavily in the next. While the higher cost of rail electrification, for example, prevents many communities from undertaking such projects, there are numerous examples where electrified rail and electric trolley bus (ETB) systems make sense – even over less expensive Bus Rapid Transit systems.

In general, electrified rail is quiet, quick and reliable, with a consistent power source. Another big advantage is that station stops can be closer together due to better acceleration and deceleration rates because of the higher performance of electric vehicles. The primary drawback is its higher cost, which ranges widely from approximately $1 million to $5 million a mile, depending on location and system type.

Recent planning efforts to consider new fixed guideway and rail electrification systems include Connecticut DOT's Danbury Branch commuter rail line, CalTrain's San Jose to San Francisco rail system in California, the Portland (Oregon) Streetcar (ETB), Schuykill Valley Metro (Philadelphia), Union County Light Rail (NJ), Boston's Silver Line Phase II BRT (ETB), and corridors within Denver's FasTracks program.

While the electrification principles are the same for each of these projects, it is important to recognize that each fixed guideway electrification project must be considered within the context of its unique environment and stakeholders, and that these factors contribute heavily to selecting and designing the right system.

Types of rail electrification

To begin it may be useful to review some of the "electrification basics" that many may al-

see "Fixed Guideway", page 2

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ready be familiar with but that are worth repeating for those unfamiliar with fixed guideway electrification. There are generally two structural types of rail electrification systems:

- An overhead contact system (OCS), consisting of wires suspended from poles typically 25 – 200 feet apart. These are known as catenary systems (for heavy rail, commuter rail and light rail trains) and electric trolley bus (ETB) systems (for streetcars and electric trolley buses). Rail vehicles and streetcars use a "pantograph" to draw power as the vehicle moves along. With steel wheels, return current passes through the rails. Rubber tire electric trolley buses use two trolley poles that collect and return current from two wires suspended above the roadway to complete an electrical circuit.

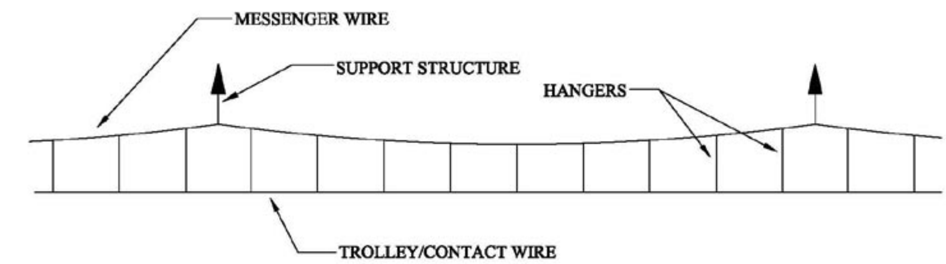

Figure 1 - Example of Simple Catenary Structure

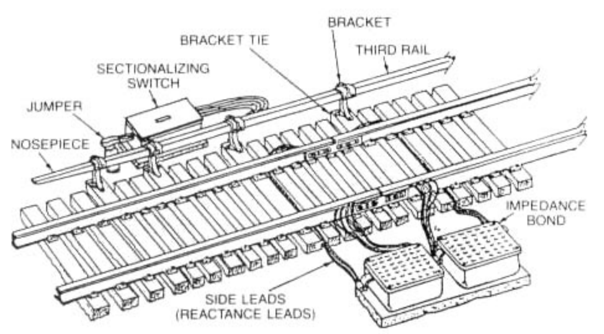

Figure 2 - Typical Third Rail Configuration

- A contact rail or third rail system, consisting of an electrified third rail running adjacent to the track allowing a "shoe" from the rail vehicles/locomotives to draw power from the third rail to power the train as the vehicles move forward.

There are several basic types of voltage systems used for electrified rail: a low voltage 600-750 V direct current (DC) system and a higher voltage (12 to 50kV) alternating current (AC) system. AC systems are used on OCS, whereas DC systems can be used for both Third Rail and OCS. The higher power needs of high speed rail networks typically require AC systems of 25kV to 50kV. Lower voltage DC systems require more substations along the route (often pre-fabricated, enclosed structures). High voltage AC systems can require fewer substations, but the footprint is fairly large and significant environmental mitigation may be necessary. Of special note to planners is the required connection into the existing high voltage transmission network (typically 69kV or greater) that AC systems require for power. This can involve regulatory agency (such as a state siting council) approvals, as well as special easements. Typically, where high voltage transmission lines are involved, there are major concerns focused on proximity of residents, and on whether the connection will be via overhead or underground transmission cables.

Third Rail, Single Contact Wire or Simple Catenary?

While third rail systems are extremely popular for grade-separated heavy rail/subway systems like BART in San Francisco, Metro in Washington, D.C., or for commuter rail systems like Long Island Rail Road in New York, third rail is not practical for in street running systems, where public access is difficult to control. Third rail systems were the first technology to

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Chair, *continued from page 1*

Thanks to all the planners who submitted excellent proposals. Our by-right sessions are as follow:

- Session 1: Sustainability in Public Transportation

Public transit, with its social, environmental, and economic benefits, is typically an important component of any sustainable development program. While public transit offers many intrinsic benefits, these benefits are greatly enhanced when public transit properties integrate sustainable concepts into their daily activities. This session will discuss sustainable design practices and their social, environmental and economic benefits.

- Session 2: Planning it Safe

A number of strategies are being implemented across the nation to reduce the human and economic costs of motor vehicle crashes. One initiative focuses on the explicit consideration of safety in the traditional transportation planning process. Implementation is supported by a broad-based coalition of transportation agencies and professional associations known as the Transportation Safety Planning Working Group.

Airports Committee

The Airports Committee, chaired by Dan Wong, with plenty of help from Whit Blanton and Larry Fabian, remains very active. Presentations were held at the ACI-NA Environmental Affairs Committee meeting in Toronto on September 18, and the FAA Airport Compatibility Planning Committee meeting in Washington DC on September 28. Both presentations addressed the Airports in the Region (AIR) Initiative.

Membership Committee

Noel Comeaux has agreed to chair our Membership Committee. You'll be hearing from him shortly regarding efforts to grow TPD's membership to "2,006 in 2006".

continued next page

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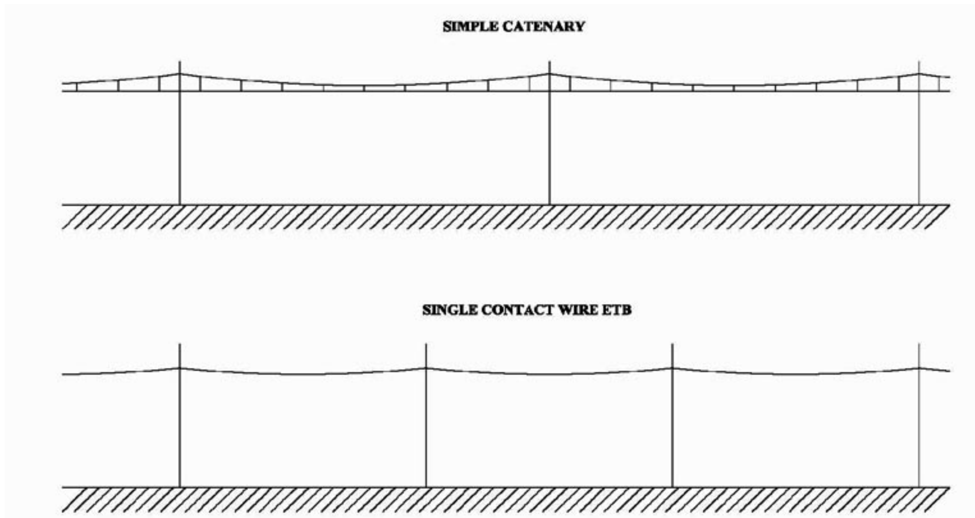
develop, as DC motor technology was best suited for propulsion in the early days of electric rail systems. In Connecticut, third rail systems have not been installed since 1905, when legislators first requested their removal due to safety concerns. Unless the system is grade separated (fenced in or not accessible to pedestrians), third rail is not considered an acceptable option there.

It can be debated whether catenary systems used for light rail vehicles are more visible than the single wire ETB systems used for streetcars and trolley buses. Urban planners have generally preferred the single wire system when minimizing the visual impact of wires is critical. Simple catenary systems have two wires (generally consisting of messenger and contact wires) compared to one on the ETB system.



There is a trade off, however. More poles are required to mitigate sagging problems on ETB systems, as Figure 3 and Figure 4 demonstrate.

Figures 3 and 4 – At left is an example of a visually unobtrusive single contact wire (ETB) streetcar system in Portland, OR. The photo at right is of Essex Street in Jersey City, where the Hudson Bergen Light Rail line runs in two directions. It is a single wire OCS (cross cabling is support wire to reduce sagging). It also shows the dedicated Light Rail Vehicle lane at left; the right lane is mixed use traffic.

The poles' attractiveness can be improved through urban design, as the single contact wire streetcar system in New Orleans demonstrates (see Figure 5, page 9).

It is essential for planners to fully consider the problem they are trying to solve before making a final decision regarding type of electrification system. As an example, the Hudson Bergen Light Rail System in Jersey City, NJ, has portions of the system with a traditional simple catenary system and a small portion with a single contact wire ETB system. Where there is single contact wire, there are a significant number of poles and support cable wires. The decision

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to install the single contact wire was intended to reduce the "wire clutter" overhead. While it eliminated some of the "wire clutter" in the air, did it really improve on the system's aesthetics? System costs were virtually the same, and it can be argued there was no appreciable difference in aesthetics, as Figure 4 suggests.

Figure 5 – New Orleans streetcar with decorative lamps on poles

When Electrification Makes Sense

There are a number of reasons why planners should consider electrified rail and transit systems in fixed guideway corridors. The primary reasons include:

- Improved operating efficiency and reliability of the mass transit system
- Elimination of particulate emissions and reduction in noise
- Adherence to environmental regulations in mass transit tunnels
- Improved travel times and better acceleration and deceleration capabilities of equipment allows for shorter trip times
- Closer spacing of stations permitted thereby serving more passengers

Other benefits can include:

- Less vehicle maintenance with no on-board diesel or gas engine
- Elimination of liquid or gas fuel storage and fueling stations
- Ability to access a diverse fuel supply via varied electric generation sources

Average Costs

A significant obstacle to implementing a fixed guideway electrification system is cost. A simple guide to assess and compare potential electrification costs is the cost per mile. The lowest price system is typically the electric trolley wire system used for streetcars, but the cost difference for other types of systems can be very little depending on the project and location. What is most important to recognize is that not all costs compare easily, as different elements are included in each cost estimate. Here are some estimates of the cost of electrification from recent studies and/or projects:

- Estimated cost to electrify 27 miles of the existing single track commuter rail line from Danbury to South Norwalk, Connecticut, is approximately $70 million, or $2.5 million per mile in FY 2005 dollars (this includes a contingency and construction management costs)
- Cost to design and install high speed rail electrification system from Boston, MA to New Haven, CT (primarily two track mainline railroad) was approximately $2 million per mile (contract cost) but nearly $4 million per mile (according to the federal auditor's review)
- Cost to install single contact wire system for the Portland, Oregon, streetcar: approximately $850,000 per mile.

Our next issue will conclude this article, which ends with an in-depth look at the environmental considerations of Fixed Guideway electrification.

Stephen Gazillo, AICP, is Project Director for Transportation Planning at Washington Group International (WGI). The author wishes to thank colleagues from WGI (especially Stan James, David Chase, Bill Salwocki and Tim Holland), David Ernst of KM Chng Environmental, and John Marczewski of Energy Initiatives Group (EIG), for their technical assistance in the preparation of this article. Mr. Gazillo can be reached at steve.gazillo@wgint.com.

New Personal Rapid Transit (PRT) Stirrings

TPD members are invited to attend the next working meeting of the Advanced Transit Association. It will explore plans for Personal Rapid Transit applications, standards, and trends. PRT is a form of high-end automated people movers that function more like automated taxis than limited linear conventional guideway transit. The meeting will take place Sunday, January 22nd at Booz Allen Hamilton offices in McLean, Virginia. This is right before the TRB Annual Meeting. TPD members qualify for the same discount as ATRA members — $25 (instead of $40 for non-members). To register, visit **www.advancedtransit.org** or send a check for $25 to ATRA, PO Box 220249, Boston, MA 02122-0013.

A Planner's Guide to Fixed Guideway Electrification Projects

By Stephen A. Gazillo, AICP

Editor's note: This is the second half of an article about fixed guideway electrification. The first half of the article can be found in the November, 2005, newsletter and is available at the TPD website (www.apa-tpd.org)

This article sets out to highlight some of the major elements of fixed guideway and railroad electrification systems, and to point out what transportation planners should be aware of as they evaluate alternatives for new public transportation projects in their communities. While planners continue to debate the cost effectiveness of rail transit as a force in urban development and land use, in those cases where rail transit is a viable option, electrification inevitably is a factor, whether one is considering streetcars, light rail, heavy-rail, commuter rail or even BRT systems.

Part II - Environmental Considerations

Land Use Impacts

One of the immediate environmental impacts of new electrification systems on local land use might result when an interconnection with the local electricity grid is required to power the system. For larger intercity rail AC systems, this can involve construction of a connection with an existing high voltage substation or transmission line some distance from the proposed route, as well as siting and construction of new substations. Underlying this issue is cost. Contractors and utility companies try to avoid expensive underground interconnections if an overhead transmission line is possible. Interconnections are less of a problem for smaller light rail and DC powered systems requiring lower voltages. Overall, impacts to land use can require significant mitigation efforts, particularly for overhead lines.

From a broader perspective, and certainly the more significant long-term issue, planners must consider the impacts of the new electrified rail or transit service on urban and regional development patterns. The improved transit service brought about by an electrified system can affect land use over time. Development patterns and densities in Long Island, as an example, have been greatly impacted by the Long Island Rail Road (LIRR), where approximately 43% of the system is electrified. The ***Making the Land Use, Transportation and Air Quality (LUTRAQ) Connection*** project in Oregon, as well as similar work in other states, probes this subject in depth. The Danbury Branch Electrification Feasibility Study in Connecticut examines the potential impact of electrification on rail ridership from a number of perspectives. Resulting travel time savings from the use of self-propelled Electric Multiple Unit rail vehicles (EMUs) indicates there would be an incremental ridership gain due to electrification. This could impact land use patterns for a number of towns along the corridor if such service were implemented.

Planners should become informed of possible intent by transit agencies and municipalities to influence these impacts, such as by use of Transit Oriented Development (TOD) controls around rail stations, or regulation of low-density development (sprawl) in areas newly served by the rail transit system.

Effects of Low Frequency Electromagnetic Fields

Much research has been conducted regarding the effects of low-frequency electromagnetic fields (EMF) from high voltage transmission lines and related effects of rail electrification systems, especially high voltage catenary lines. EMF, which is produced by any energized electric line, has been the subject of many research efforts and publications. However, there is little consensus or proof that EMF from transmission lines or electrification systems has health impacts. Planners need to keep abreast of EMF research results and should be aware that this could be presented as an Environmental Justice and overall public issue, especially when determining the location of transmission lines and substations, and when the installation of energized catenary wires may be near residential uses.

see "Fixed Guideway", page 6

Attention TPD Members:

TPD business meeting and reception at **TRB** - see page 15 for details!

Tram in Orleans, France – typical example of streetscape improvement project in Europe tied to new Tram system project. Catenary wires, attached to the buildings and decorative poles, are barely visible against clear sky. Street was completely redesigned during tram project.

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Air Quality

Electrification projects often involve a public health tradeoff. On the one hand, exhaust emissions are reduced within the right-of-way. However, power plant emissions from tall stacks that may affect the region are more dispersed, according to David Ernst, senior environmental planner with KM Chng Environmental. A careful, localized, all-inclusive analysis of emission creation and reduction has to be performed to get the full picture. Ernst has evaluated air quality impacts for numerous fixed guideway electrification systems across the U.S. The pollutants of most concern for transit projects usually are fine particulates and nitrogen oxides, and to a lesser extent volatile organic compounds, carbon monoxide and air toxics.

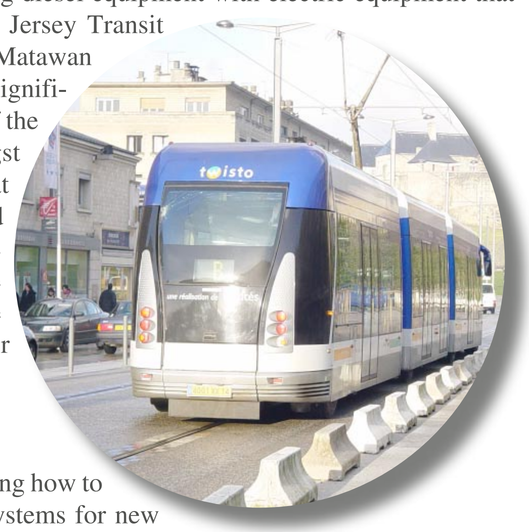
Strasbourg, France tram system with grass growing in right of way.

He notes that a direct comparison of vehicles from one system to another generally ranks diesel-electric locomotives in commuter rail operations with the highest level of particulate emissions, followed by Diesel Multiple Unit (DMU) equipment, buses and finally Electric Multiple Units (no vehicle-based emissions). Actual emissions are highly variable and are dependent upon the particular generation mix (fuel type and combustion technology) of the electric system powering the rail system. Direct comparisons should also take into consideration ridership and capacity. Regardless of the rail vehicle technology, the overall impact on regional emissions will depend on the system's ability to attract new riders, i.e., to induce a mode shift.

Given that the overall goal is to attract riders from their cars and onto rail or transit vehicles, planners should examine each project in terms of its net emissions impact. Ultimately, the net emissions impact (when examining the number of trains added minus the number of car trips reduced) depends on the ability to persuade people to ride the train instead of taking their car.

Noise and Vibration

Most electrified vehicles are significantly quieter than fossil fuel vehicles (diesel-electric locomotives, diesel buses, etc.). Electric Multiple Unit vehicles (self-propelled electric rail vehicles) have quick acceleration, quick deceleration and generate lower noise levels than other conventional fossil fuel types. Newer, rubber tire vehicle technologies are even quieter than conventional steel wheel equipment. Planners need to be aware that there may still be a need for noise mitigation, particularly where there has never been transit service. There are also other considerations when replacing diesel equipment with electric equipment that generates lower noise levels. When New Jersey Transit electrified its commuter rail service from Matawan to Long Branch along the Jersey shore, a significant safety campaign was required for all of the adjacent communities, particularly amongst schoolchildren. Quieter trains meant that there was a greater risk that residents and children playing in proximity would have far less warning of an oncoming train. The safety campaign proved effective and the electrified service has run successfully for nearly two decades.



Right - The "Twisto" rubber tire system in Caen, France, developed by Bombardier and installed by Spie Batignolles. Note the single track guideway and rubber tires. Vehicles can leave guideway in certain locations to service outlying communities, but such practice is limited and not seamless.

Visuals and Aesthetics

Numerous articles have been written regarding how to reduce the visibility of overhead contact systems for new electrified rail and fixed guideway systems. The most important lesson learned here is that

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The Bordeaux, France tram system applies an innovative traction power system developed by INNORAIL that replaces the overhead contact system with a power supply imbedded in pavement. Pedestrians can walk on the contact rail, as it is energized only when the tram vehicle passes over it. Vehicle is shown on left and traction power rail imbedded in cobblestone is shown on right. Reliability of the system has not yet been proven.

any efforts to accomplish this must be undertaken at the earliest planning stages of a project. Mitigation techniques employed include: reducing the number of poles through spacing and shared structures, camouflaging them with landscaping and trees, minimizing the number of trolleybus turns and carefully selecting pole types. The electric trolley bus (ETB) system is considered the least intrusive visually as it involves the fewest number of wires (although it is not ideal).

Impacts result not only from the overhead wires, but also from the transmission connections and supply substations. Mitigation techniques include underground lines and metal-enclosed and/or indoor switchgear in an architecturally pleasing building.

Planners need to keep in mind the subjectivity of aesthetics. Regardless of efforts to mitigate the visual impacts of catenary and trolley overhead systems, there will always be a physical intrusion in the landscape. At the same time, electrified systems have less smoke and odor, and the related improvements at stations can create visually appealing environments.

Safety

Historically, rail electrification was, in part, a response to the health and safety concerns regarding steam trains operating in the tunnels into New York. The greatest safety concerns with electrified rail typically involve inadvertent contact with energized wires. Guards and barriers are often provided in areas where the public might gain access to areas near live wires or equipment, and workers are trained in how to properly shut off and make safe the facilities they are working on. For the general public, the primary safety concerns are avoidance of contact with third rail systems (hence higher levels of security trackside) and avoidance of contact with overhead contact wires. Where the risk is greatest, such as on bridges over electrified rail, special fences and bridge barriers to block the view and prevent contact have been extremely effective in preventing accidents. Overall, there have been few occurrences of public injury due to accidents along electrified rail systems. Experimental systems, such as the ones currently in development in Italy and France and described elsewhere in this article, would allow a roadbed-installation of the contact system which is energized only as the train or vehicle passes over it.

Technological Advances

There have been several technological advances in rail electrification systems, with the most recent being the electrified “wireless” tram (light rail) by Innorail in Bordeaux, France (see image, top left). The system in Bordeaux is essentially a third rail system, but the third rail is imbedded in the pavement and can be walked on – it is energized only when the tram vehicle passes over it. Planners are excited at the prospect of a safe third rail system for in-street running vehicles. However, the Innorail system has not yet been proven, as the Bordeaux wireless tram has suffered from reliability issues.

Translohr rubber tire test vehicle, which is bi-directional, at the Lohr Industries test track in Obernai, France. System utilizes traditional catenary and traction power design and is planned or in service in Italy and France. Vehicles are modular units and are designed to operate completely in a fixed-guideway.

Other innovations include the rubber tire trams manufactured by Translohr (image, left) and Bombardier (lower image, page 6) and in service or in development in France and Italy. These systems operate in urban centers like a fixed guideway tram but with a single guide rail; in some instances they can operate off-line and run like buses to external locations. Future technologies also include low-speed Maglev systems, which utilize an elaborate guideway system with magnets to “elevate” the train above the rail. The high costs of these systems to date have limited their development and implementation.

In Europe, low floor trams utilize the technology of light rail transit with modern state-of-the-art design to create a much sleeker transit image, as the Strasbourg (top image, page 6) and Orleans (page 3) tram systems in France demonstrate.

Public Perceptions – A Personal View

During the past three decades, I have been involved in a number of different rail and trolley electrification projects. These range from efforts to help educate the public on the electrification of NJ Transit’s North Jersey Coast Line commuter rail system from Matawan to Long Branch; to participation in the engineering and planning team engaged to perform design of

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***Fixed Guideway**, continued from page 8*

Amtrak's new high speed rail electrification system between Boston and New Haven, CT; to a recent feasibility study examining possible re-electrification of the Danbury Branch of the New Haven Line in southwestern Connecticut.

When undertaking these projects, planners faced the same basic task: educating the public on the benefits of rail and trolley electrification systems. It is this process, more than any other, that will have a significant impact on the project's acceptance and probability of success. Listed below are some examples:

Observed Acceptance of Rail Electrification Systems

System	Population Density*	Observed Degree of Acceptance	General Comment
NJ Transit North Jersey Coast Line – Electrification from Matawan to Long Branch, NJ	Monmouth County: 1304 pop./sq. mile 510 housing units/sq. mile	High	Commuter rail service to Manhattan – high acceptance due to perceived benefit of significant travel time improvement with electrification
Amtrak High Speed Rail Electrification – Boston, Massachusetts	Norfolk County: 1627 pop./sq. mile 639 housing units/sq. mile	Medium	Intercity travel – opposition by adjacent homeowners due to perceived increase in train vibrations; general acceptance by community at-large
Amtrak High Speed Rail Electrification – Providence, Rhode Island	Providence County: 1504 pop./sq. mile 613 housing units/sq. mile	High	Intercity travel – high acceptance due to benefit of improved rail travel time to Boston or NY
Amtrak High Speed Rail Electrification – Coastal Connecticut Communities	New London County: 389 pop./sq. mile 166 housing units/sq. mile	Low	Intercity Travel – strong vocal opposition due to visual impacts and perception of electromagnetic field intrusion; lack of local benefits from the project (Acelas tend to run through this area without stopping)
Danbury Branch of the New Haven Line, Connecticut DOT and Metro-North Railroad	Fairfield County: 1410 pop./sq. mile 542 housing units/sq. mile	High	Commuter rail service to Manhattan – projected high acceptance due to perception of faster commute times to Manhattan

*Source: U.S. Census 2000

High Acceptance – defined as high level of support at public meetings and in media with little or no opposition

Medium Acceptance – defined as high level of support with some vocal opposition at public meetings and in media

Low Acceptance – defined as strong vocal opposition in media and at public meetings with low level of support

Stephen Gazillo, AICP, is Project Director for Transportation Planning at Washington Group International (WGI) and can be contacted at steve.gazillo@wgint.com. *The author wishes to thank colleagues from WGI (especially Stan James, David Chase, Bill Salwocki and Tim Holland); David Ernst of KM Chng Environmental; and John Marczewski of Energy Initiatives Group (EIG), for their technical assistance in the preparation of this article.*