

# A STREETCAR NAMED REVIVAL

North American cities experiment anew with century-old concept

by Paul Grether

**T**imes are exciting for the streetcar business in the United States. After the last 140 years saw the rise of the electric street railway and its subsequent decline, there is again the beginning of another boom of streetcar construction taking shape. Dozens of cities in the U.S. are either planning and building or operating modern streetcar systems. And during the next few years, new streetcar lines are scheduled to open in cities that long-ago abandoned these colorful cars. Just like the decline of streetcar systems, the reasons behind their rebirth are often misunderstood and the subject of debate. The sudden growth of the streetcar can be attributed to the rebirth of the American central city and generational changes, declines in automobile use, and a desire by cities to redevelop and repopulate neighborhoods in ways that promote sustainable lifestyles. Take a journey on the following pages on a streetcar named “Revival!”

Though only a few cities boast streetcar transit today, a wave of newly built modern streetcars, like the ones on Seattle Streetcar's South Lake Union line, are in the future for more than 20 cities. *David Honan*





Portland Streetcar's network has become famous in transit circles for their success with more than 13,000 daily riders. Mike Bjork



Look out! Modern streetcar systems that can carry hundreds of passengers and share rights-of-way with automobiles are in the works from Detroit to Dallas. David Honan

## THE REVIVAL BEGINS

Portland, Ore., opened the first new modern streetcar system in the U.S. in 2001. What the Portland Streetcar system pioneered was to show that there is a rail transit market for short trips in a city's central business district similar to a circulator shuttle bus. And there is a growing belief that a modern streetcar line improves the economics of a community — enough so that Jim Mark, chief executive of a Portland-based real estate company, supports streetcars by serving as the streetcar company's board chairman.

"[Streetcars] inspire developers to invest along the streetcar line. Since the city's first streetcar alignment was announced in 1997, new development used, on average, 90 percent of the buildable space along the route," Marks wrote to *The Oregonian* in 2013. "That percentage drops to just 43 percent three blocks away."

Locals claim that streetcars repopulated and redeveloped Portland's once vacant industrial Pearl District neighborhood. Cities then and now envy Portland's ability to turn around that industrial strip using



**Grooved girder rails were once common, but are now only made overseas.** David Honan

its streetcar investment, which now boasts 13,000 daily riders in less than 15 years of operation. Seattle and Tacoma, Wash., followed suit, but it wasn't until the Federal Transit Administration let streetcar projects compete with light rail and buses for federal grants that floodgates opened.

Before federal funding for streetcars, local communities or individual investors bore the risks of streetcar projects. Portland residents accepted this risk and agreed to fund a streetcar system by adding assessments to commercial land owners' property taxes.

Transit systems often use local government bonds or general fund tax subsidies to achieve the same goal. Portland's first line was 4 miles long, while a September 2012 line extension using transit administration money expanded the system to 14.7 track miles and helped the city cement its place as a streetcar leader in the U.S.

While the Oregon metropolis owes much to European cities in design innovation during the last 50 years, Portland's system has roots in the Electric Railway Presidents' Conference Committee of the 1930s, which developed legendary PCC cars still in use today [see "Where did PCC come from?" "Ask TRAINS" Page 62].

It's the PCC's descendant, the American Public Transportation Association, which published the Modern Streetcar Vehicle Guideline. This guide is quickly becoming the standard go-to manual for transit planners and engineers as they consider how to scratch-build new streetcar systems. It reflects the new reality of streetcar system planning and purchasing by the transit industry, the international modern streetcar vehicle market, new technologies, and related requirements.

Continued development for streetcar projects, though, depends on continued federal support and on the success of current projects. So far, North American streetcar systems have generated positive public reaction. There has been enough good will to encourage cities to plan or begin building streetcars in the next five years, alone.

## MODERN BY DESIGN

As the term "modern" suggests, modern streetcar designs have advanced greatly since the PCC car days, both in response to new regulations and new technologies. Regulations cover such areas as accessibility, fire protection, crashworthiness, and safety while much of the new technology was developed in Europe, where streetcar systems flourished with public funds during the decades when North American systems were largely abandoned. It was during this time that streetcar vehicle and infrastructure designers met and overcame past problems with reliability, high operating costs, and limited capacity. The best of modern designs even give new systems the option to operate without overhead wires.

Before this latest advance, streetcars and other electrified trains rarely strayed from the wires that delivered power to their motors. The advance, really, has been in ground-level systems that activate when a streetcar is present, and in batteries and super capacitors.

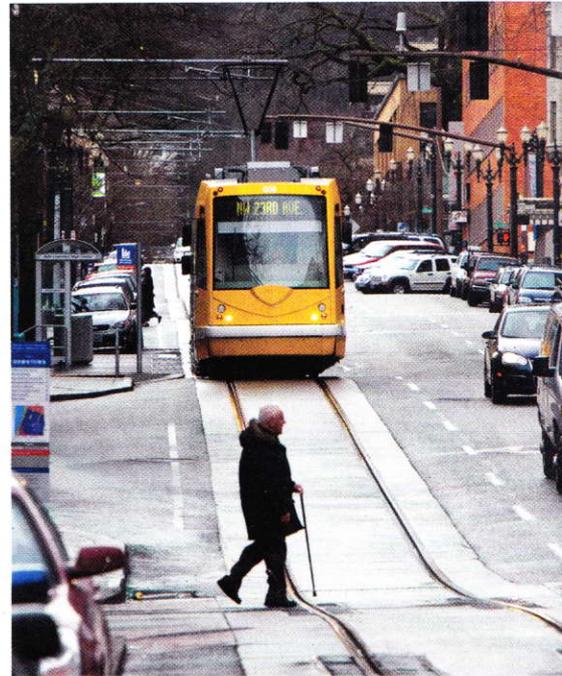
The French city of Bordeaux, for instance, uses a ground-level power supply developed by Alstom to travel wirelessly for short distances. Dallas' Brookville Equipment Corp.-built streetcars will use lithium-ion batteries to cross a historic bridge where undesirable overhead wires would ruin aesthetics.

Other streetcar designs are following the lead of light rail brethren and using super capacitors, which store electricity in a static field, weigh less than the equivalent-power battery bank, and discharge power gradually — something ordinary capacitors cannot do.

Brian Eichler, a sales director for Maxwell Technologies, says his company has super capacitors installed in Siemens and Alstom vehicles and in cars on Portland's TriMet light rail network. Eichler says super capacitors in transit service last at least 10 years, while both super capacitors and batteries enable a streetcar to travel up to two miles without externally supplied electricity. The trade-off is that streetcars require more energy to move the extra weight and the technology to include the extra storage is often expensive.

In practice, future lines with off-wire systems will work much the same as Seattle Streetcar's First Hill line. It uses off-wire technology to avoid complex connections when it crosses electrified King County Metro trolleybus lines. Streetcar operators lower pantographs and switch to banks of on-board lithium-ion batteries at crossings until reaching their own wires again at the bottom of the hill.

Operators then raise the pantograph and let the batteries recharge.



**Modern streetcars enable the disabled and elderly to board easily.** David Honan

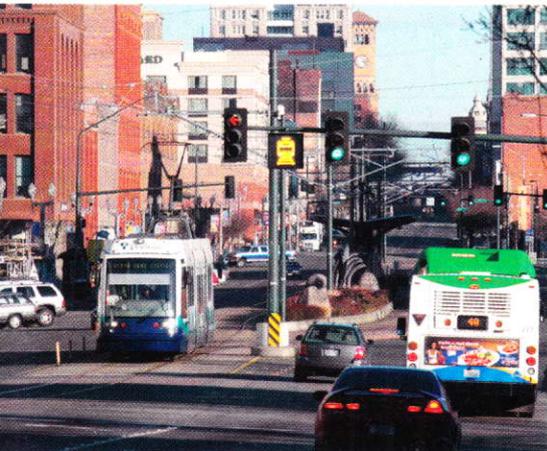
## WHAT MAKES A STREETCAR 'MODERN?'

**So how is the modern** streetcar different from light rail and from streetcars of the past? Modern streetcar vehicles share many of the same attributes of light rail vehicles and should simply be thought of as somewhat lighter than light rail, with subtle differences.

The benefit of using an overhead wire for traction power is that the infrastructure is flexible, and the same vehicle can run in a street like a bus or run at high speed on grade-separated rights-of-way into suburbs.

The major differences between modern streetcars and light rail can generally be found in a vehicle's physical attributes as follows:

- Modern streetcars are designed to operate as single fixed-length units, with additional capacity created by adding additional sections to a single articulated vehicle — light rail trains add capacity through multiple-unit trains.
- A modern streetcar system makes extensive use of unrestricted mixed-traffic street-running whereas light rail utilizes exclusive rights-of-way, often with railroad-style gated grade crossings and limited street running.
- Stop spacing on a modern streetcar is more frequent.
- Streetcar stops are far more basic than light rail and are designed to blend into the urban street. — Paul Grether



Buses and streetcars can share routes for different reasons. David Honan

## WHY NOT A BUS?

The question most often heard during political debates surrounding modern streetcar projects is “Why not just use buses instead?”

The first reason is capacity.

Even the smallest of modern streetcars have a capacity twice that of the largest transit buses in use in North America today. The largest modern streetcars can operate as 5-, 7-, and sometimes 9-section articulated vehicles, carrying more than 200 people.

A second reason is accessibility.

The way that streetcars are designed and operate, wheelchairs do not need to be specially secured or tied down, and as a matter of course, people with disabilities and anyone else can more easily step into and out of a low-floor streetcar.

The third and maybe most important reason is psychological.

With permanent track, wires, and station stops, streetcars are perceived to be predictable and less intimidating than buses, whose on-vehicle fare collection can induce anxiety for those new to transit and whose routes can be difficult to understand and are subject to change.

The modern streetcar has shown in Portland and other cities that it can drive economic redevelopment. Certain cities have chosen to introduce streetcars for this very reason. While transportation benefits of a modern streetcar are also important, the ability of the modern streetcar to transform urban neighborhoods is what is driving cities to be the champion of the streetcar rather than a transit authority. — Paul Grether



## STREET-LEVEL POWER

Getting streetcars moving with modern electric systems was another challenge. Most of today’s streetcars now use alternating current traction motors for better durability and lower maintenance costs instead of cam-and-resistor direct current motors. Regenerative braking that recharges batteries or super capacitors also sends electricity back into overhead wires to power other streetcars — an important “green” aspect of modern advances. And while traction motors use A.C. power, the electricity received and regenerated is almost always 750-volt direct current, which does not arc from the contact wire to other metal objects, such as tall automobiles and trucks.

The added safety is important because modern streetcars employ low-floor designs that take the cars lower to the ground and closer to people than ever before.

While the low-floor concept is new to the United States, European systems have used the designs that put passengers at street level since the 1990s.

A low-floor streetcar lets passengers hop on and off more quickly and offers greater access to disabled or elderly passengers and those stowing luggage or bicycles. Low-floor designs used today come in 50-, 70-, and 100-percent versions, that is, streetcars with that rough percentage of floor space close to street level.

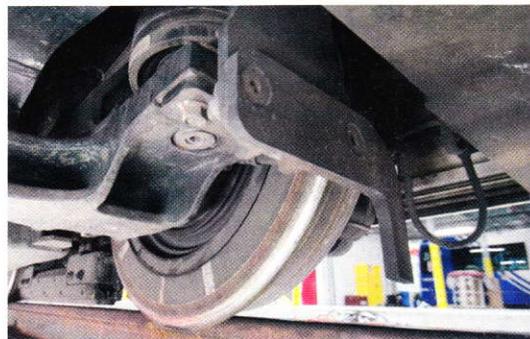
Cars with 70-percent low floors use standard running gear. Powered trucks located at the ends of the car underneath high-floor sections enable these cars to use standard traction motors mounted on the axles through a conventional gearbox. Inside, steps lead down from the ends of the

car into the remaining low-floor space.

In North America, it’s the 100-percent low-floor version that is so new. This type of streetcar has no steps anywhere in the vehicle and even doors located on the end of the vehicle are stepless. The use of 100-percent low-floor vehicles requires that traction motors, gear boxes, and braking equipment are located on the outside of the wheels and results in non-traditional running gear often without solid axles. Toronto, Cincinnati, and Kansas City, Mo., have new 100-percent low-floor cars on order.

Unlike streetcars of old that took on passengers in the middle of the street, modern versions use specially designed stops to comply with the Americans with Disabilities Act. Hydraulic active suspensions level the cars’ floors at stops to exactly 14 inches for fully level boarding. The cars also have bridge plates to enable wheelchair access on systems without active vehicle suspensions or with low platforms.

Unsurprisingly, the coming of low-floor vehicles means much of the equipment that



Modern streetcars have rubber-infused wheels to improve performance. Paul Grether

would have been underneath the car has been moved to the roof including propulsion equipment, brake resistor grids, batteries, and air conditioning. As a result, the backshops for these new streetcars must have overhead mezzanines where most equipment maintenance happens.

And on top of all the technological changes, new streetcar systems' need to both shift capacity quickly and still turn tight corners has meant the biggest innovation of all: the articulated modular vehicle.

These squirmy streetcars operate through tight curves by using the vehicle's articulation to rotate the vehicle rather than the vehicle's trucks. This enables systems to run longer streetcars with greater passenger capacity without the "swing" of older cars into adjacent lanes or parked automobiles.

Modular designs are helped along with wheel profiles that are different from Association of American Railroad standards and customized for each city. Wheel treads and flanges also are typically smaller than AAR standards. And, unlike a solid steel railroad wheel, streetcar wheels often incorporate an elastic layer of rubber ring elements that creates a smoother and quieter ride. Much like a steam locomotive driving wheel, these streetcar wheels have interchangeable tires that can be re-profiled when worn.

## **FEDS RETOOL POLICY**

For all the advances in streetcar designs and planning in North America, much was made possible with policy changes at the Federal Transit Administration.

While both part of the U.S. Department of Transportation, the Federal Transit Administration is different from its railroad counterpart, the Federal Railroad Administration, in that the Federal Transit Administration is primarily a grant-making agency, while FRA is primarily a safety regulatory agency. In an attempt to limit the role of the federal government in direct regulation of rail transit when the federal transit program was created in the 1960s, Congress required the Federal Transit Administration to pass responsibility for regulating rail transit safety to the states, typically state departments of transportation.

When the Portland Streetcar system was being planned in the 1990s, transit administrators still considered streetcars to be the same as light rail. The grant funding available for rail transit was rated in such a way that streetcar projects could not compete since the transit administration did not consider redevelopment of urban areas and transit service quality. Recent Federal Transit Administration policy weighs the benefits that modern streetcar projects bring in terms of urban redevelopment and creating communities where people can live with



**Modern streetcars use special boarding platforms, while older networks board passengers in the street. Mike Bjork**

## STREETCAR MAKERS



Joshua Anderchek

**Bombardier** built 204 Flexity Outlook modern streetcars for the Toronto Transit Commission. The Flexity Outlook is a 100-percent low-floor vehicle but has the design innovation of having small axles, eliminating the issues of independently rotating wheels on Toronto's legacy system. The Flexity streetcar has overseas success, but it is unknown if Bombardier will pursue small streetcar orders. Bombardier's U.S. final assembly plant is located in Plattsburgh, N.Y.



Brookville

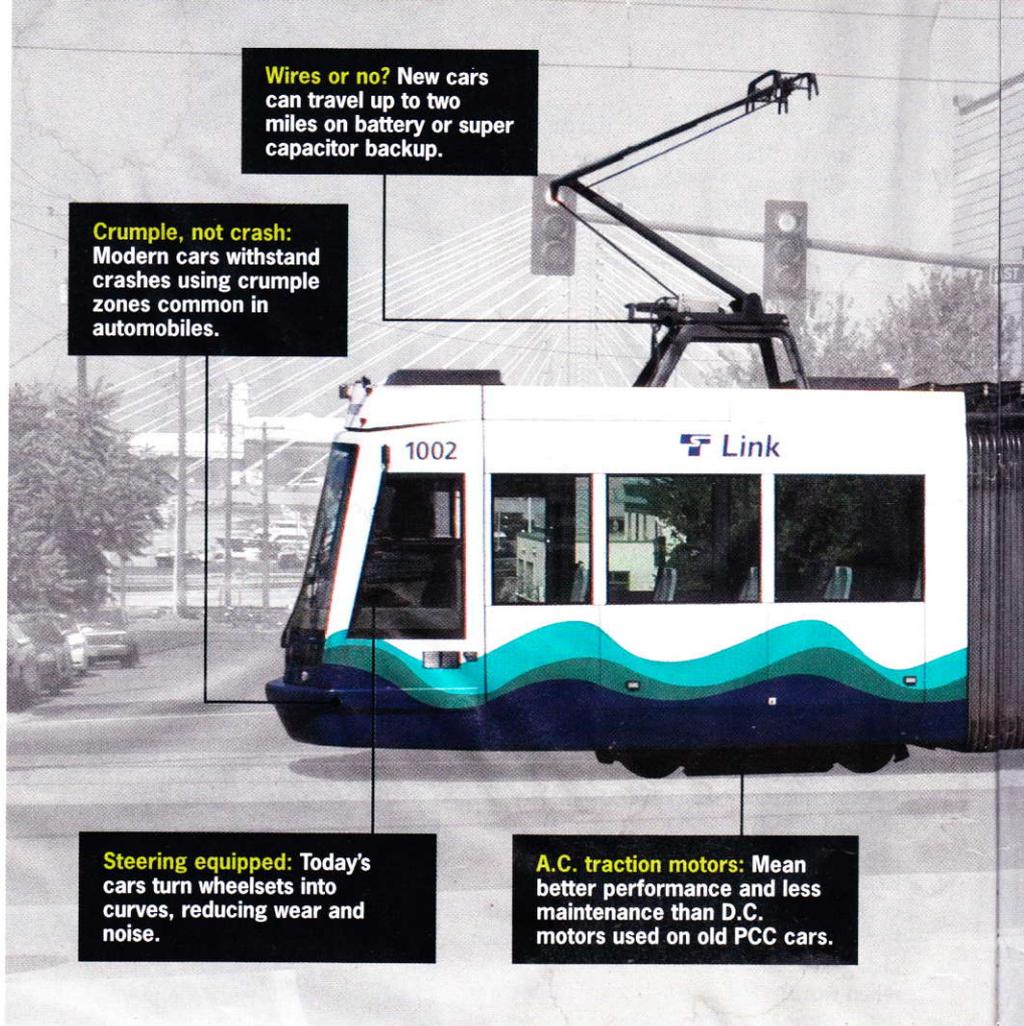
**Brookville** Equipment Corp. is well known for its heritage streetcar work. Brookville has rebuilt PCC cars for San Francisco and Philadelphia systems. The company has created a partial low-floor modern streetcar called the Liberty. Dallas ordered two Liberty cars for its Oak Cliff project, which will include an off-wire battery storage system and includes options to order two more. Brookville is one of only two U.S.-owned carbuilders and is located in Brookville, Pa.



Paul Grether

**United Streetcar**, a subsidiary of Oregon Iron Works, based in suburban Portland, Ore., is the other U.S.-based streetcar builder. It has a final assembly plant in Clackamas, Ore., and has a license from the Czech firm Skoda to make Astra 10-T 50-percent low-floor streetcars. These are United's model 100 and 200 streetcars. United Streetcar has orders from Portland, Tucson, Ariz., and Washington, D.C.

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**Wires or no?** New cars can travel up to two miles on battery or super capacitor backup.

**Crumple, not crash:** Modern cars withstand crashes using crumple zones common in automobiles.

**Steering equipped:** Today's cars turn wheelsets into curves, reducing wear and noise.

**A.C. traction motors:** Mean better performance and less maintenance than D.C. motors used on old PCC cars.

fewer automobiles on the street.

An additional effect of the transit administration's involvement in streetcar projects is the "Buy America" requirement that affects track infrastructure and vehicles most. Buy America requires that final assembly and 60 percent of the content of rail transit vehicles, including streetcars, occurs or is made in the United States.

This has required foreign car builders to establish final assembly railcar plants in the U.S. and has led to development of a substantial domestic sub-supplier industry for items such as door systems, heating and air conditioning, seating, wheels, and more. Buy America also requires that 100 percent of steel products, such as rail, special trackwork and other major components of the system are made in the U.S. As a result, streetcar system designers are using standard railroad T-rails and block rail manufactured by companies like steel giant ArcelorMittal in Steelton, Pa., instead of the preferred new-milled grooved girder rail. Grooved streetcar rails are now only produced overseas.

### LESSONS FROM A CANADIAN COUSIN

Visitors to Toronto's downtown are familiar with the ubiquitous red cars — Urban Transit Development Corp. cars — from the 1970s and 1980s sparking and



**New rail in this Portland sculpture highlights streetcars' importance.** TRAINS: Brian Schmidt

shunting on their routes. As those cars retire, they make Toronto the first city on the continent to face what legacy systems in Europe have already — a need to transform itself into a modern streetcar system. Toronto's routes are overcrowded. The vehicles do not have air conditioning and are not accessible to the disabled.

Enter Bombardier's Flexity Outlook. Toronto officials ordered 204 modern,

**Arc-less:** 750-volt D.C. voltage is common for new streetcar lines because it arcs less than A.C. electricity.

**Flexible:** Articulated streetcars carry more people while still making tight curves.

**Up on top:** Street slinking transit cars put air conditioners, inverters, and more on the roof.

**Accessible:** Low-floor entries are fully ADA-compliant and often drop to 14 inches off the ground.

**Better than 50/50:** Low-floor designs have at least 50 percent of the passenger space at street level. Certain models have floors that are entirely street level.

**Green up:** Regenerative breaking means streetcars return energy back to the grid without adding pollution.

**Modular:** Vehicle designs accommodate extra sections to make longer cars possible.

**Low floor:** The newest streetcars go 14 inches to the ground.

## WHAT'S 'MODERN' ABOUT MODERN STREETCARS

Photo by Mike Bjork, photo illustration by Drew Halverson

5-section articulated, 100-percent low-floor, accessible streetcars from the Canadian company. This was in tandem with upgrades to the streetcar rail infrastructure. Upgrades include switching to overhead wire compatible with pantographs (current operations still use a traditional trolley pole), spread out stops to speed up service, platforms where possible, and segments of semi-exclusive rights-of-way in street medians with traffic signal priority.

When other U.S. cities have streetcar basics in place, they can aim for expanding capacity as Toronto has on its 51 miles of single and double track. Unlike light rail, where capacity is often increased by building consists of coupled trains, streetcar systems evolve to longer vehicles so as not to waste crowded and valuable street space with unoccupied train length.

Much like European streetcar systems, the Toronto system may well be creating a path for other U.S. legacy and new streetcar systems to follow as they seek to incrementally improve and quicken service in response to growing demand and the need for fleet replacements. More than 20 cities on the continent are set to follow its lead.

### ELEVATED IMPORTANCE

Mature streetcar systems in Europe and Toronto show that as networks grow be-

yond the downtown they start to take on a more line-haul transit role. This requires streetcar systems to have faster scheduled speeds and more capacity. Future streetcar systems in the U.S. may operate articulated vehicles that can hold hundreds of passengers in a single car and still navigate streetcar rails on narrow urban streets with tight radius curves.

And, the demand for faster schedule speeds will result in better priority for streetcars on city streets and the use of separate lanes or rights-of-way in certain areas. Streetcar systems in development in San Antonio, Texas, and the Columbia Pike project in the Virginia suburbs of Washington, D.C., are being developed to upgrade the capacity of existing major bus corridors and have the potential to reflect mature streetcar developments overseas.

The Atlanta Streetcar has been built with provisions for future light rail operation, including generous curves, high-capacity electricity distribution systems, vehicles with provisions for future multiple-unit operation, and other attributes that make it ready for future extensions.

Despite healthy growth, the market for modern streetcar manufacturers in the United States remains small when compared with the rest of the world. Several cities entering the final planning and con-



Cars on Seattle's South Lake Union line go to bed in a shop with elevated platforms enabling easy access to the roof. David Honan

## STREETCAR MAKERS

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CAF USA

**CAF USA**, Construcciones y Auxiliar de Ferrocarriles, is considered a medium-sized carbuilder on the international market, but it is winning many orders with its URBOS 100-percent low-floor streetcar. Based in Spain, the U.S. final assembly plant for CAF is in Elmira, N.Y., which has produced light rail vehicles for Pittsburgh, Sacramento, Calif., and Houston. CAF was successful in a five-car Cincinnati and four-car Kansas City order, which includes options for an additional 25 cars.



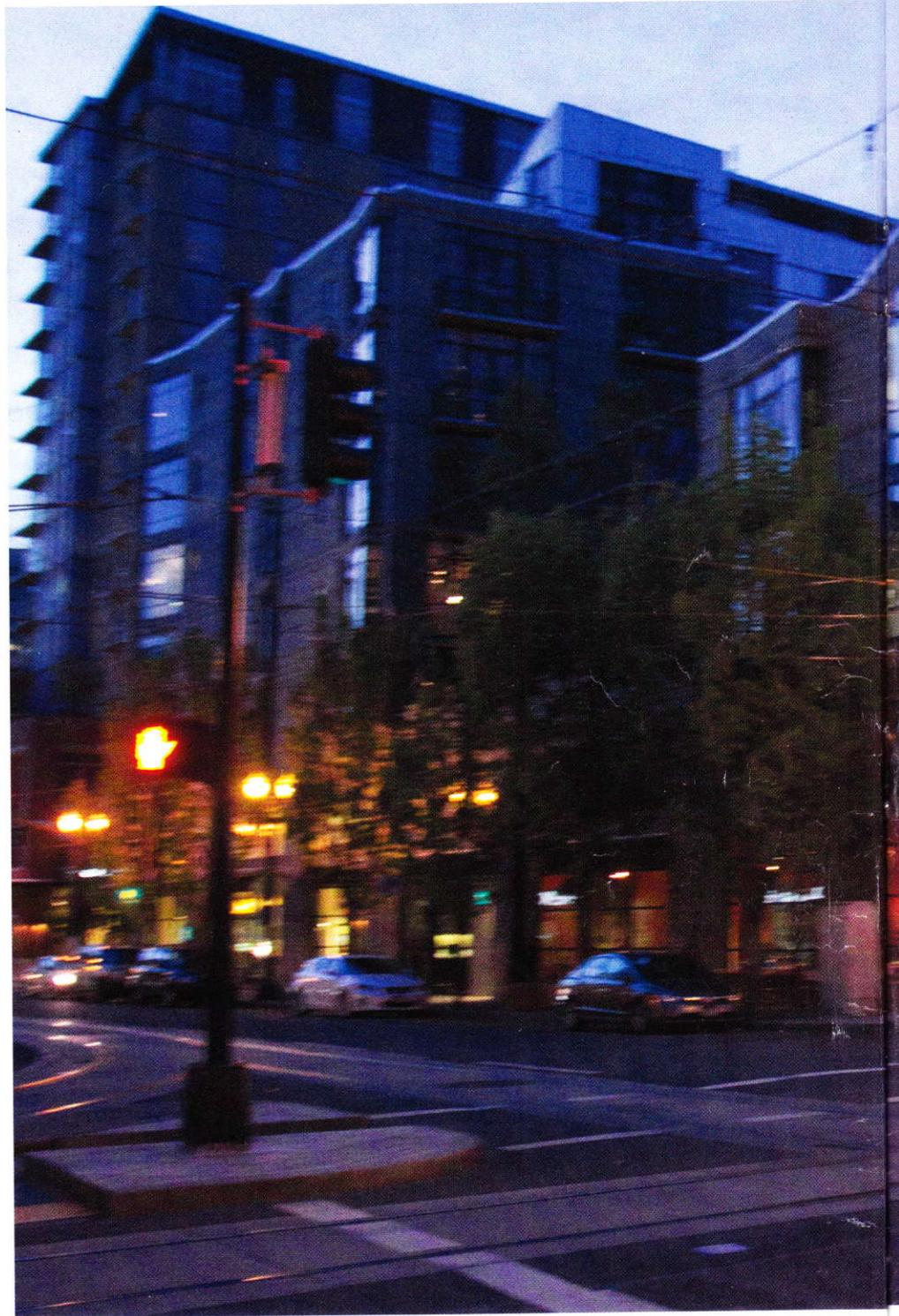
Paul Grether

**Inekon**, based in the Czech Republic, once partnered with another large Czech Republic carbuilder Skoda, but the two have since parted company and now make streetcar vehicles on their own. As a supplier to many former Eastern European systems, Inekon had a hand in providing the first modern streetcar vehicles to the Portland, Seattle, and Tacoma, Wash., systems with their Trio 50-percent low-floor platform and Skoda 10T models. These pioneering systems were built without federal funding.



Paul Grether

**Siemens Mobility USA**, by far the dominant producer of light rail vehicles in the United States, helped start the U.S. light rail revolution in the early 1980s with the first order for U2 cars for San Diego. While it is a German company, Siemens operates a semi-autonomous, large, and integrated production and assembly plant in Sacramento, Calif., where it designs, fabricates, and assembles modern streetcars for the North American market. — Paul Grether



struction phases will soon request competitive proposals from the car builders.

Of these projects, wire-free technology, in the form of on-board energy storage, is being planned in Seattle, Dallas, Detroit, and Fort Lauderdale, Fla.; with the last two expected to announce winning bidders later this year. Bigger orders are coming, with San Antonio looking for 10 or more cars for the largest new-build modern streetcar system yet.

The U.S. capital area too will get street-

cars, with the DC Streetcar project, now in its testing phase and the Columbia Pike project in Arlington, Va. This suburban Washington, D.C., project could also be the first to implement a modern streetcar as a line-haul transit capacity replacement for buses.

It could also be the first application of longer, 5-section modern streetcar vehicles in the U.S. Philadelphia's SEPTA will have to start consideration of replacement of their venerable Kawasaki streetcars, which



replaced PCC cars in the early 1980s and are reaching the end of their service life.

Philadelphia's order could be an example of a Toronto-style upgrade of a legacy system in the United States bringing additional passenger capacity and accessibility for the disabled.

Competition among builders for these streetcar orders is fierce, but to win a contract, builders are accommodating demand for better technology built-in to new cars with increased low-floor accessi-

bility, sleek styling, reliability, along with the ease of maintenance.

And when the builders deliver, it will be to a new tier of cities setting themselves apart with clean, safe, efficient, and easy-to-use transit — the modern streetcar. **I**

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**Portland's streetcar successes are perhaps the best advertising for further modern system development. Neon signs are almost as good.** Kyle Weismann-Yee

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