PART 6

Vintage Trolley Operations

Vintage Trolleys: A National Overview

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This overview introduces vintage trolley (VT) case studies and premieres VT as a valid transit concept to transportation professionals. VT is defined and compared with other transit modes. Its characteristics and applications are analyzed relative to the communities in which it is an integral element. VT successes and shortcomings are highlighted.

The talk today is often about returning to basics; embracing the fundamentals that provide reliable, no-frills, user-friendly products and services. This principle (and sometimes its opposite) is aptly demonstrated in public transportation and specifically in light rail transit (LRT). Vintage trolley (VT) equipment and facility design demonstrate the practice of basics in transit.

VT appears to be more than a momentary gimmick, supplying nostalgia for tourists and rail buffs. VT is growing more rapidly than any other form of urban rail transit: 23 VT new starts in 20 years.

DEFINITION

This is an opportunity to define VT for the first time. VT as a transit mode is now established enough to qualify for a standard definition, but young enough that no one has yet given it an official designation.

The term "VT" is carefully considered. The *T* applies to either "tram" or "trolley" quite well. Other terms popularly applied to VT include "heritage trolley," "historical streetcar," and combinations of these terms. Use of trolley car replicas in some VT reduces the validity of applying "historical" or "heritage" to describe such operations. Other elements of VT properties may not be authentically historical or part of local or national heritage. "Vintage" is a more flexible word that describes age or the frequent perception of age. A vintage wine, for example connotes quality as well as a significant era that may not necessarily be "old."

A universal tendency seems to be to define VT using the trolley vehicle as the sole identifier. Even the fledgling VT systems now in operation demonstrate that VT is better defined by a combination of features, including rolling stock, service, infrastructure, management, and operating environment.

One thing VT is not is a minibus or truck/van chassis with a body decorated to resemble a San Francisco cable car or traditional streetcar. The term "vintage trolley" is also proposed for common usage to avoid confusion with rubber-tired highway vehicles that attempt to mimic rail cars.

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What then is VT? A short definition of vintage trolley is offered as a standard for the genre: Vintage trolley is a variant of light rail transit that provides year-round urban transit service using genuinely historical or replica vintage rail equipment with heritage-compatible infrastructure.

Though considered part of the VT family, urban funiculars and cable lines such as in San Francisco, Pittsburgh, and Dubuque are excluded from this analysis. Admittedly, they exhibit most of the characteristics of VT but differ in geometry and propulsion. Tables 1–3 attempt to show the fine line between electric traction museums and VT properties. Trolley museums and museums that feature trolley displays, such as San Jose's Kelley Park or Calgary's Heritage Park, are relegated to Table 3 and are otherwise not treated in the analysis.

Consider existing transit President's Conference Committee (PCC) streetcar operations such as those in Philadelphia, Pittsburgh, Toronto Harbourfront, and Newark in a VT context. But are they VT? The cars qualify as historical vehicles if one uses the motor vehicle department eligibility criteria for issuing historical license plates. Within the transit spectrum, however, these PCC properties are treated as modern operations with dated but hardly obsolete technology. As their transit managers clearly do not wish to impart an image of vintage equipment or nostalgia, most PCC operations do not quite fit the VT mold. Similarly Fort Worth's Tandy Subway uses PCC car apparatus with replacement contemporary-design bodies and amenities. Tandy's LRT rail transit property is clearly not vintage by intent.

Proposed trolley operations in Buffalo's Tonawanda Corridor and San Francisco's Embarcadero will employ second- or third-hand PCCs and reclaimed infrastructure and right-of-way. Although this appears at first glance to be a financial expedient rather than an intent to create a vintage image, both the vehicle and right-of-way are of some historical value. San Francisco's Muni, for example, plans to take advantage of the PCC car's appeal by applying historical paint schemes of various PCC operators across North America. Hence they qualify as VT.

PCC cars do have other potential to further the VT concept. Surplus PCC components are being used to construct replica VT cars as recently demonstrated on Portland's four-car order from Gomaco. Nelson, British Columbia, is using an ex-Toronto PCC to supply parts to rebuild a vintage car. In some cities that once operated PCCs on the surface, there are proposals to return cars to their original habitats as they are retired by their current owners. Minneapolis, Vancouver, Detroit, Dallas, San Diego, and El Paso reportedly are active in such efforts for promotional, historical, and perhaps even transportation reasons. Surplus PCCs are being purchased by fledgling VT operators (Cincinnati, Frederick, Keokuk, and Johnstown). These circumstances make a strong argument for treating recycled PCCs as VT.

TABLE 1 VT Properties in North America, March 1992

Location	Operator/Name	No. of Cars[a]	Route Miles
Chattanooga, Tenn.	Chattanooga Choo-Choo	1	<0.5
Dallas, Tex.	McKinney Ave. Transit Authority	5 (4)	1.4
Denver, Colo.	Platte Valley Trolley		
	Denver Rail Heritage Inc.	1 R	3.5
Detroit, Mich.	Detroit Citizens Ry./DDOT	9 (3)	1.2
Ft. Collins, Colo.	Ft. Collins Mun. Ry. Soc.	2 (1)	1.5
Ft. Smith, Ark.	Ft. Smith Trolley Museum	2	<.5
Galveston, Tex.	Galveston Island Trolley,	4 R	4.7
	Galveston Park Board		
Lowell, Mass.	Lowell Nat'l Historic Park		
	DOI, National Park Service	3 R	1.5
Nelson, B.C.	Nelson Electric Tramway Soc.	2 (1)	1.4
New Orleans, La.	Riverfront Trolley		
	RTA/Riverfront Transit Coal.	7	2.2
New Orleans, La.	St. Charles Line, RTA	35	6.5
Orlando, Fla.	Grand Cypress Resort, Hyatt	4	3.5
Philadelphia, Pa.	Penns Landing Trolley		
	Buckingham Valley Trolley Inc.	7 (4)	1.1
Portland, Oreg.	Vintage Trolley Inc./Tri-Met	4 R	2.5
Portland, Oreg.	Willamette Shore Trolley	1	6.0
Sacramento, Calif.	Regional Transit		
	(temporary service, discontinued)	0	2.0
San Antonio, Tex.	San Antonio Museum Assoc.		
	(service discontinued)	1+(0)	>1.0
San Francisco, Calif.	Historic Trolley Festival Market		
	St. Ry. Inc.	16 (13)	3.6
San Jose, Calif.	Santa Clara County Transit	5	4.5
Seattle, Wash.	Seattle Metro	5	2.0
Toronto, Ont.[b]	Toronto By Trolley Car/TTC	3	—
Tucson, Ariz.	Old Pueblo Trolley Inc.	1	—
Yakima, Wash.	Yakima Interurban Lines Inc.	4	7.0

NOTE: VT-like cable and funicular lines are excluded. This inventory totals 23 VT properties, of which 16 are representative for comparison and analysis; these are underlined in the table.

[a]*R* = replica.

[b]Toronto's newly opened Harborfront LRT Line uses overhauled PCCs. It is not classified as a VT in this analysis because its operator, TCC, clearly wishes to impart an image of a modern, new facility in new development. Toronto's tour trolley using pre-PCC and PCC equipment is included above for purposes of this analysis.

TABLE 2 VT Properties Planned, Committed, or Under Construction in North America, March 1992

Location	Name/Operator	No. of Cars	Route Miles
Algiers, La.	Algiers Landing Rest.	1	<.5
Aspen, Colo.	Aspen St. Ry. Co.	6	N/A[a]
Brooklyn, N.Y.	Waterfront/Atlantic	1	N/A
Buffalo, N.Y.	Tonawanda Corridor/NFTA	12	5.2
Charlotte, N.C.	Charlotte Trolley Inc.	2	1.3
Chattanooga, Tenn.	Downtown Trolley/CARTA	0	3.0
Cincinnati, Ohio	Cincinnati St. Ry./CTHA	7	2.5
Cleveland, Ohio	Flats Trolley/RTA	0	.5
Edmonton, Alberta	High Level Bridge/ET	1+	<2.0
El Paso, Tex.	El Paso City Lines	5+	<4.5
Frederick, Md.	Frederick Trolley Comm.	1	4.0
Memphis, Tenn.[b]	Mid America Mall/MATA	11	2.4
Mexico, D.F.	Tour Tram STE/STC (disc)	—	N/A
New Orleans, La.	Canal St.		3.9
	Loyola/Rampart (proposed)	38	1.1
New Orleans, La.	Riverfront Extensions	0	6.3
Orlando, Fla.	"OSCAR" City of Orlando	1	3.0
Orlando, Fla.	Disney World	0	N/A
Portland, Oreg.	River Place/Union Sta.	0	2.3
Richmond, Va.	Electric Trolley/GRTC	1	0.6
San Diego, Calif.	Gas Lamp Dist. Trolley	—	N/A
San Francisco, Calif.	F Market St./Muni and	12+	3.6
	Embarcadero/Muni	—	1.7
Vancouver, B.C.	False Creek Waterfront	3	2.0

NOTE: Of the 24 VT proposals in 21 cities inventoried above, those shown underlined are under construction or are in other stages of advanced implementation. Proposals in early planning: Johnstown, Pa.; Glendale, Calif.; Pottstown, Pa.; Omaha, Nebr.; Lincoln, Nebr.; Newark, Ohio; Hagerstown, Md.; Tampa, Fla. Gordon Thompson's unpublished inventory of VT and LRT proposals lists another 45 proposed projects.

[a]N/A = proposed route mileage not available or determined.

[b]Opens in 1992.

TABLE 3 North American Electric Traction Railway Museums, March 1992

Location	Name/Operator	No. of Cars	Route Miles
Baltimore, Md.	Baltimore St. Railway Museum	13	<1
Boone, Iowa	Boone & Scenic Valley	4+	15
Branford/E. Haven, Conn.	Shore Line Trolley Museum	80+	1.5
Calgary, Alberta	Heritage Park	2+	1
Clear Lake, Iowa	Mason City & Clear Lake Railway Historical Soc. (Iowa Traction)	3	12
Cleveland, Ohio	Trolleyville USA	20+	<2.0
Delson, Quebec	Canadian Railway Museum	15+	1.5
Duluth, Minn.	Lake Superior Museum of Transportation	3	<.5
East Troy, Wis.	E. Troy Railroad	10+	7.2
Edmonton, Alberta	Ft. Edmonton/ERRS	13	1.1
Elgin, Ill.	Fox River Trolley Museum	10+	1.5
French Lick, Ind.	Indiana Railway Museum	2	>1
Glenwood, Oreg.	Trolley Park/OERHS	5+	1.5
Golden, Colo.	Colorado Railway Museum/RMRRC	2	<.5
Hibbing/Chisholm, Minn.	Iron World USA	2	2.5
Kennebunkport, Maine	Seashore Trolley Museum/NERHS	200+	2
Kingston, N.Y.	Trolley Museum of N.Y.	8+	1.5
Minneapolis, Minn.	Como-Harriet/Minn. Transportation Museum	7	1
Mt. Clemens, Mich.	Michigan Transit Museum	4	4.0
Mt. Pleasant, Iowa	Midwest Electric Railway	6	1.1
Noblesville, Ind.	Indiana Transportation Museum	3+	1
North Prairie, Wis.	N. Prairie Electric Railway	5	1
Orbisonia, Pa.	Shade Gap Electric Railway	20+	1
Perris, Calif.	Orange Empire Ry. Museum	130	2.5
Rio Vista, Calif.	Bay Area Electric Ry. Museum	80+	1.5
Rockford, Ill.	City of Rockford Parks	1	—
Rochester, N.Y.	NY Museum of Transportation	3	<1
Rockwood, Ontario	Halton County Radial Railway/OERHS	10+	1
San Jose, Calif.	Kelley Park (City of San Jose)	2	.3
St. Louis, Mo.	National Museum of Transport	10+	—
Union, Ill.	Illinois Railway Museum	30+	>2
Vancouver, B.C.	Burnaby Village Museum	5	—
Warehouse Pt., Conn.	CT Electric Railway Association	50+	1.5
Washington, Pa.	Arden Railway Museum/PRMA	20+	1
Wheaton, Md.	Nat'l Capitol Trolley Museum	15	2
Worthington, Ohio	Ohio Railway Museum	13+	1.5

NOTE: Including major railway and general purpose museums featuring operating trolleys (four museums are static displays). These 36 museums, holding over 750 cars, constitute a network that interacts with VT properties in complementary ways. Most notable is the exchange of parts, equipment, and technical advice. Some, like the Kelley Park VT shop, provide restoration skills. Other urban electric railways and traction museums like Baltimore could become VT.

VT Versus LRT

The above definition of VT has been scrutinized and modified to suit a panel of VT operators, designers, and planners. Yet it is not quite enough to differentiate genuine VT from tourist rides, LRT, trolley museums, or hybrid transit operations that happen to employ trolleys. Describing VT as a submode of LRT invites comparison of their general, mostly qualitative, characteristics (see Table 4).

Additional Features and Tendencies

An inventory of North American rail properties yielded a list of 23 operations that exhibit some strong VT characteristics. Of these, 16 are selected as best representing the VT ideal as defined above. Clearly these VT properties were placed and designed by their sponsors to support certain community purposes, civic facilities, and commercial land uses. VT, once built, also tends to attract and nurture complementary urban features, such as historical districts, gentrifying neighborhoods, sightseeing attractions, and trendy shopping areas. These downtown features are some of the strongest techniques for renewing urban "main street" America. Their presence with VT suggests that VT itself is a powerful tool in improving, or at least helping to stabilize, downtowns. Table 5 shows these features measured against the 16 representative VT properties.

The 16 representative VT properties also demonstrate some common physical characteristics that help reveal the nature of VT. They are expressed in aggregate terms as averages in Table 6.

Electric freight railways not now routinely used for revenue passengers, like Keokuk Junction Railway, Gomaco's test track, and some noncommon carrier electric railways are not included here. Some of these freight railways host vintage trolley and interurban rolling stock.

Like each of their LRT brethren, every VT property is unique. Some, like Seattle's, are integrated with the local transit system in terms of fares, labor, schedules, and other aspects of operations. Others, such as the McKinney Avenue Transit Authority in Dallas, are fully independent from the metropolitan transit operator. Yet others, like the New Orleans Riverfront, are partially integrated. Funding and op-

TABLE 4 Light Rail Versus VT Characteristics

Characteristic	LRT	VT
Infrastructure	New equipment; some reuse of rights-of-way	Reclaimed ROW track, equipment
Labor	Paid	Part time, paid, volunteer
Technology	Leading edge	Traditional
Capital cost	Moderate >$10 million/mile	Low <$10 million/mile
Car performance	High (55 mph, 3 mphps)	Low (30 mph)
Functions	Line haul, distribution	Distribution, CBD shuttle
Route distance (shortest/longest)	>3 mi (Denver, 3.5)	<5 mi (Galveston, 4.7)
Image and perception	Modern/advanced	Traditional/nostalgic
Demand features	Sharply peaked	Uniform loading
Peak use	Rush hours (7–9 AM, 4–7 PM)	Nonpeak (10 AM–4 PM, 7–10 PM)
Predominant users (travel motivation)	Commuter (routine)	Tourist/shopper (discretionary)

NOTE: Although these characteristics are indeed generalities and may not apply in all cases to all LRT and VT operations, they are offered here to help distinguish some of the less obvious, less visual differences between LRT and VT.

TABLE 5 Features of 16 Representative VT Properties

Percentage	Feature
81	Serve one or more major tourist attractions/districts
63	Serve a CBD shopping district
63	Of North American VT host cities are located west of the Mississippi River. Considering all 23 VT properties, 70 percent are located in the West. Of those VT properties being proposed, slightly over half would be located in the West. The siting tendency of VT is coastal, not directional. This appears to be related to centers of commerce being on water and VT's affinity for waterfronts.
50	Serve a riverfront or waterfront area
50	Serve convention, civic, or sports center
50	Have expanded or are actively planning to do so
50	Use reclaimed streetcar or railroad track and/or right-of-way
44	Use exclusive right-of-way for all or a portion of their route distance
31	Operate jointly with LRT [Portland, San Jose, San Francisco, Toronto (Tour Tram), Sacramento (disc.)]
25	Use replica cars exclusively (Galveston, Lowell, Denver, Portland); none now uses a combination of historic and replica VT cars; only 10 percent of the total North American VT fleet is replica; including one demonstrator and two in museums, the total is 15
6	Have cars employing on-board internal combustion power generation; Of the 16 representative VT properties, only Galveston's four Miner-built cars feature this means of propulsion; of the total of 23 VT properties, Denver's single Gomaco-built open car is the only other diesel electric VT

NOTE: Of a total of twenty-three vintage trolley properties now in North America, sixteen are selected in this paper that best embody the features of VT as defined herein. These sixteen VTs reflect very diverse local conditions. Though each is different, they display some commonalties that may provide guidance to those considering a VT in their area. As we learn more about what works in VT, the common features could become means of predicting VT project success.

TABLE 6 General VT Physical Characteristics

Characteristic	Average Value
Car fleet size	5.5 cars (82 cars on 15 properties, minus New Orleans St. Charles' 35-car fleet)
Route miles	2.9 mi (40.8 total miles on 14 VT properties, Toronto and San Francisco operations excluded)
Fare	$1.36 (ranging from $0.25 to $3.75 over 12 representative VT lines)
Capital cost	$3.4 million/mi (includes 7 properties ranging from Galveston's $2.6 million/mi to New Orleans Riverfront's $3.4 million/mi, and St. Charles total rehab at $7.2 million/mi. VT costs are rising. Seattle's initial 1.4-mi former rail line cost $2.6 million/mi. Its 0.6-mi extension in street cost $10.8 million/mi.

NOTE: These are averages of selected VT.

erating arrangements vary though nearly all VT has the support and some financial assistance of local business, corporate, and retail commercial interests.

Vulnerabilities

Detroit's Downtown Trolley, San Antonio's Brewery Line, and Dallas' McKinney Avenue Transit Authority demonstrate VT's vulnerability, just as the VT operations in Seattle, New Orleans, and San Jose demonstrate VT successes. VT patronage is more discretionary than conventional transit or LRT use, which is based largely on daily commuting. VT typically is linked to shopping, tourist travel, sightseeing, restaurants, and a host of other particularly recession-prone enterprises. A depressed downtown needs more than just a VT to revive it. A VT alone in an economically depressed central business district (CBD), absent other active economic remedies, is doomed. VT financial performance varies and defies comparison. None, however, appears to be self-sustaining using conventional accounting criteria. (For a list of VT properties planned, committed, or under construction, see Table 2.) Experience in early VT operations suggests a few conditions that contribute to VT popularity and success.

First, strong and consistent political will, endowed in a single dynamic leader or group of leaders is an ingredient for VT success. It is essential for VT new starts. Seattle's and Santa Clara's VTs demonstrate the power of strong and persistent individual leadership such as that of City Council President George Benson and Supervisor Rod Diridon, respectively.

Second, commercial and business interests' endorsement and support reflected in a willingness of retail establishments to tolerate momentary interruptions of trade during VT construction is important. Other support measures include forming special assessment districts, corporate VT car sponsorship, and volunteerism of various forms. Businesses appear to demonstrate more tolerance toward VT than other rail transit because costs are lower and VT is perceived as serving as an attraction in addition to a means of transportation. VT also has the potential to help place and manage CBD parking least disruptively. Memphis' Mid-America Mall and San Jose's downtown promise to provide examples of the mutual benefits of VT and traditional retail downtowns.

Third, a well-defined transportation mission is essential to VT to differentiate it from an amusement ride or solely as a tourist attraction. San Francisco's three cable car lines demonstrate the importance of a transport function in the context of an historical (and in this case a landmark) property. Insufficient route length to reach or link downtown attractions betrays a flawed transportation mission.

And fourth, an already strong CBD is desirable, but not essential.

PAST AND FUTURE OF VT, AN EVOLVING PHENOMENON

The first "new" VTs appear in the mid-1970s. Previously, San Francisco Muni's three cable lines and New Orleans' St. Charles line were regarded merely as survivors of a past era. However, both demonstrated the lasting appeal and value of VT to the extent that their advocates prevented nationally publicized attempts to replace VT with "modern" bus transit. San Francisco and New Orleans were prototypes for early VT. (Like urban inclines, Muni's VT cable system is excluded here.)

The next step in the evolution of VT was Toronto's and Mexico City's vintage tour trams of the early 1970s. These were vintage, pre-PCC cars operating on relatively modern streetcar and LRT properties, primarily for sightseeing.

Next, projects imported vintage trolleys and trams from Portugal, Argentina, Australia, and other nations. The domestic supply of vintage trolleys had been scrapped, placed on static display, or preserved in operating trolley museums, of which more than 30 are located in the United States and Canada. (See Table 3 for a list of major traction museums and museums featuring early street transit.)

Yakima opened its VT line in 1976 and Detroit's VT project started in the same year, introducing what Julien Wolfe has termed "purpose built lines." Seattle's Waterfront Line appeared in May 1982. Lowell's VT followed in 1985 and Orlando's Grand Cypress Resort VT in 1986, representing VT in recreational environments. Since then, the number and variety of VTs has increased. Galveston, New Orleans, Riverfront, and McKinney Avenue VTs opened within a year of one another (1988–1989).

At least 24 major new VT projects are now proposed, in planning, or under construction. Some are in areas where VT is already present. Of these, five are committed in property acquisition or under construction. Some of these may assume the complexion of operating museums. Others, like Memphis' VT and Orlando's "OSCAR," will become transit-type VTs.

The future of VT is promising on several counts. The landmark federal ISTEA (Intermodal Transportation Efficiency Act of 1991) legislation contains alternatives analysis funding for two VT projects: the downtown Orlando VT distributor for OSCAR and Chattanooga's CBD loop. At $5 million and $2 million, respectively, these study funds are in the capital cost magnitudes for VT. Federal funds, matched by local public and private resources have already been expended in New Orleans, Portland, San Jose, Galveston, Seattle, Lowell, and Dallas' McKinney Avenue. One might cite federal funding eligibility by Federal Transit Administration (formerly UMTA) as a sign that VT has arrived as a bonafide transit mode.

The first generation of VT properties are already considering expanding their routes. Seattle, Detroit, Lowell, and New Orleans have already done so.

A small VT family of enterprises has arisen specializing in various aspects of implementation. Three firms offer vintage trolley vehicles, two building replicas from scratch and one importing and adapting foreign trams. A modest consulting business has emerged to advise prospective VT operators and to plan and design VT facilities.

VT is not only a North American phenomenon. It exists elsewhere with tour trams mixing with state-of-the-art light rail vehicles. Melbourne, Hong Kong, Bern, and Zurich provide special vintage trams that serve meals and receptions while traveling their streetcar systems. Fares and revenue are premium.

A profile of the initial phase of New Orleans' Riverfront Streetcar Line provides a good case study of successful VT practice. Funding was a blend of private sources (22 percent),

FIGURE 1 North American VT and LRT properties and proposals.

transit operator (22 percent), redevelopment district (5 percent), and UMTA (51 percent). The 1.5-mi line was built in a matter of months at a cost of $3.9 million a mile on reclaimed railroad right-of-way. The New Orleans Belt Railway continues to use adjacent tracks on common right-of-way. The streetcar line officially opened on schedule and on time for the Republican National Convention, 48 days after ground breaking. Daily ridership was forecast at 2,100 fares. Typical operating days yielded around 5,000, with peak holiday and weekend daily fares hovering around 7,000. The facility was expanded with additional cars and track. Now ambitious plans include extensions beyond both extremities of the Riverfront Line up to 8 mi and standard gauge extension up Canal Street and across Loyola and Rampart Streets using newly built replicas of the distinctive Perley-Thomas streetcars of New Orleans.

RESEARCH AGENDA

Some lessons can be learned from VT basics that may be applied to other transportation facility planning. Further, the data presented here suggest that VT merits serious consideration for more research and understanding. If one considers the number of properties alone and the astonishing average of one VT "new start" per year for the last two decades, then VT qualifies as the most popular and fastest growing of the rail modes being built in North America. By some counts, more than 60 light rail proposals are now being considered, many of which are VT. As the map (Figure 1) shows, VT is ubiquitous and should not be ignored by transit professionals.

Will VT encourage LRT or does it confer a stigma of obsolescence to rail transit? Does VT demonstrate a new approach to pedestrian-scaled and traffic-compatible transit distribution in downtowns? How does VT relate to CBD parking infrastructure? What is the real cost-benefit performance of VT? How does VT help comply with new initiatives in energy, clean air, historical preservation, and disabled access? Is VT a valid, less costly substitute for downtown people movers? How is VT best financed? Can it ever be self-sufficient? Should VT merit separate treatment as a subcommittee in the TRB hierarchy? These are just a few of the issues that demand attention in a VT research agenda.

ACKNOWLEDGMENTS

Little is formally written about VT. Although some VT properties are featured in trade and fan magazine articles, most VT information appears in news columns, newspaper articles, and promotional material provided by VT operators. In its present state, VT defies assembling a bibliography.

Practically no serious research has surfaced. The technical literature, financial and technical feasibility studies, to the

extent that they exist, have not found their way into publishing channels. Those papers that exist are not research in nature, but tend to be expositions of "how we did it." These experience-sharing documents are useful in their comprehensiveness, but they do not focus on specific VT issues.

All of this means that to produce an overview of a subject like VT, one spends a lot of time on the phone, verifying details and interviewing operators. First drafts of this paper were circulated to a peer group of nearly 20 professionals representing varied interests in VT. The author appreciates their information, constructive comments, and suggestions. Thanks go to J. Aurelius, G. Benson, H. Botzow, E. Clark, J. Graebner, W. C. Graeub, M. Gaddis, R. Landgraf, J. McCall, F. Miklos, D. Minister, A. Morrison, M. K. Murphy, T. Parkinson, R. Roberts, F. Schultz, G. Thompson, J. Wilkins, and J. Wolfe.