

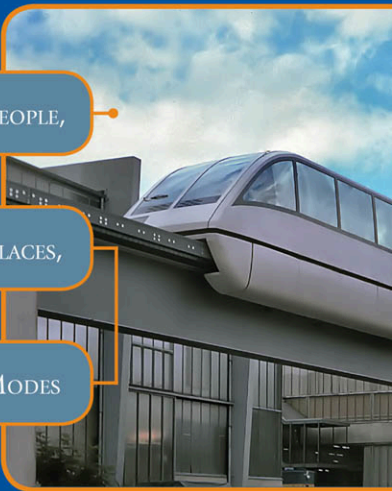
# Automated People Movers 2009

CONNECTING PEOPLE,

CONNECTING PLACES,

CONNECTING MODES

PROCEEDINGS OF THE 12TH  
INTERNATIONAL CONFERENCE



**ASCE**

Edited by  
Robert Griebenow, P.E.

This is a preview. Click here to purchase the full publication.



# AUTOMATED PEOPLE MOVERS 2009

*Connecting People, Connecting Places,  
Connecting Modes*

---

PROCEEDINGS OF THE TWELFTH INTERNATIONAL CONFERENCE

---

May 31–June 3, 2009  
Atlanta, Georgia

SPONSORED BY  
Committee on Automated People Movers  
The Transportation & Development Institute (T&DI)  
of the American Society of Civil Engineers

EDITED BY  
Robert R. Griebenow, P.E., S.E.



Published by the American Society of Civil Engineers

Library of Congress Cataloging-in-Publication Data

Automated people movers, 2009 : connecting people, connecting places, connecting modes : proceedings of the twelfth international conference, May 31-June 3, 2009 : Atlanta, Georgia / sponsored by Committee on Automated People Movers, The Transportation & Development Institute (T&DI) of the American Society of Civil Engineers ; edited by Robert R. Griebenow.

p. cm.

Includes bibliographical references and indexes.

ISBN 978-0-7844-1038-7

1. Personal rapid transit--Congresses. I. Griebenow, Robert R. II. American Society of Civil Engineers. Committee on Automated People Movers.

TA1207.A995 2009

388.4'1--dc22

2009015799

American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, Virginia, 20191-4400

[www.pubs.asce.org](http://www.pubs.asce.org)

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefore. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

*Photocopies and reprints.*

You can obtain instant permission to photocopy ASCE publications by using ASCE's online permission service (<http://pubs.asce.org/permissions/requests/>). Requests for 100 copies or more should be submitted to the Reprints Department, Publications Division, ASCE, (address above); email: [permissions@asce.org](mailto:permissions@asce.org). A reprint order form can be found at <http://pubs.asce.org/support/reprints/>.

Copyright © 2009 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 978-0-7844-1038-7

Manufactured in the United States of America.

# Preface

APM 2009 is the 12th in the series of international automated people mover conferences and continues the tradition of transit professionals meeting together to share the latest technology, projects and planning of automated transit.

The conference theme, “Connecting People, Connecting Places, Connecting Modes – APMs” reflects the conference’s focus on APMs and driverless transit systems as connectors for people, places and modes in cities, airports and private developments. Around the world automation in transit is accepted as safer and less costly than manual operation. Full automation has been applied to a wide range of transit technologies, from rapid transit systems to small circulator systems. APMs have matured, and this conference has recorded the experience and lessons learned from recent projects and developing technologies.

Special recognition goes to the organizers of the first APM conference: Murthy V.A. Bondada, Conference Chair, and Edward S. Neumann, Program Chair, who through their creative and persistent efforts on the APM Committee crystallized the first conference in 1985. Now every two years, this conference brings together the planners, inventors, designers, suppliers, builders, owners and operators of automated transit systems to share their experiences, technologies and innovative ideas. Past conferences, held around the globe, have built an international fraternity of profession and friendship.

APM 1985 – Miami Florida  
APM 1989 – Miami, Florida  
APM 1991 – Yokohama, Japan  
APM 1993 – Irving, Texas  
APM 1996 – Paris, France  
APM 1997 – Las Vegas, Nevada  
APM 1999 – Copenhagen, Denmark  
APM 2001 – San Francisco, California  
APM 2003 – Singapore  
APM 2005 – Orlando, Florida  
APM 2007 – Vienna, Austria

The editor acknowledges the significant efforts of the many authors who through their papers have created the record in these APM proceedings in both time and place.

Robert Griebenow

# Acknowledgments

## Conference Steering Committee

- Hal Lindsey, A.M.ASCE, Lea+Elliott, Conference Co-chair/Exhibits and Sponsorships
- Robert Griebenow, P.E., S.E., M.ASCE, Berger/ABAM, Conference Co-chair/Technical Program
- Janice Li, Lea+Elliott, Track Chair
- J. Sam Lott, P.E., M.ASCE, Kimley Horn, Track Chair
- Martin Lowson, FREng, Automated Transport Systems Ltd, Track Chair
- Larrence L. Smith, P.E., F.ASCE, Consultant and ASCE APM Standards Committee Chair, Track Chair
- William Sproule, Ph.D., P.E., F.ASCE, Michigan Technological University, Track Chair

## Conference Co-Sponsors

- Advanced Transit Association (ATRA)
- Airports Council International North America (ACI/NA)
- Institution of Civil Engineers
- City Mobil
- INRIA

## ASCE Staff

- Jon Esslinger, P.E., F.ASCE, Director, Transportation & Development Institute of ASCE
- Debra Tucker, CMP, Conference Manager
- Sean Scully, ASCE, Exhibits
- Joanna Colbourne, Sponsorships
- Donna Dickert, Publications

# Contents

## *Airport Experiences*

<b>Landside APM Planning at Seattle-Tacoma International Airport .....</b>	<b>1</b>
Dave Tomber, Harley Moore, and Bob Griebenow	
<b>NDIA APM: Building an APM in a Terminal Building .....</b>	<b>11</b>
Steve Beebe, Jackie Yang, and Harley L. Moore	
<b>The Dallas Love Field People Mover Connector .....</b>	<b>20</b>
Terry Mitchell, Diego Rincon, and Scott Kutchins	
<b>The Sacramento International Airport APM .....</b>	<b>34</b>
Jenny Baumgartner and Harley L. Moore	
<b>DFW Skylink: Tracking Success .....</b>	<b>44</b>
David Taliaferro	
<b>Operations and Maintenance at Atlanta Airport .....</b>	<b>50</b>
Melvin Redd, Russell Woodley, and Jerome Page	
<b>O'Hare ATS—The Teenage Years .....</b>	<b>56</b>
Dennis Gary and Mark Piltingsrud	
<b>APM Systems: The Key to Atlanta Airport Expansion .....</b>	<b>69</b>
John Kapala	
<b>Planning and Integration—MHJIT at Atlanta Airport .....</b>	<b>80</b>
Sambit Bhattacharjee, John Kapala, and Mike Williams	
<b>Expanding the APM System at Atlanta Airport .....</b>	<b>91</b>
Gregory A. Adams, Thomas Sheakley, and Frank Jeffers	
<b>The Impact of APMs on Property Value .....</b>	<b>105</b>
David D. Little and Margaret Picard	
<b>London Heathrow Terminal Five APM Project .....</b>	<b>116</b>
Jon Brackpool and Glenn Morgan	
<b>MIA Mover APM: A Fixed Facilities Design-Build Perspective .....</b>	<b>128</b>
B. M. Schroeder	
<b>MIA Mover Procurement .....</b>	<b>141</b>
Sanjeev N. Shah, Larry Coleman, Margaret Hawkins Moss, and Franklin Stirrup	

## *Major Activity Centers*

<b>APM Feasibility Study for the Vienna Central Station Development Area .....</b>	<b>151</b>
Heimo Krappinger	
<b>Las Vegas People Mover Integration Potential .....</b>	<b>164</b>
Wayne D. Cottrell	

<b>Planning and Procurement of the Doha, West-Bay APM.....</b>	<b>179</b>
Kamel-Eddine Mokhtech, Sanjeev Shah, Hassan Eisa M. Al-Fadala, Ghanim Hassan Al-Ibrahim, and Hassan Qaddoura	
<b>PRT Case Study at the Village West Development in Kansas City, Kansas.....</b>	<b>190</b>
Stanley E. Young, Peter Muller, Moni El-Aasar, Dean Landman, and Steven Schrock	
<b>Project Funding Opportunities .....</b>	<b>201</b>
Sanjeev N. Shah and Larry Coleman	
<b>Evolving Clark County APM Code Requirements .....</b>	<b>212</b>
David Mori and Eric Troy	
<b>A Campus Transportation System for Michigan Tech.....</b>	<b>219</b>
William H. Leder, Frank W. Baxandall, and William J. Sproule	
<b>California University of Pennsylvania (CALU)—Maglev Sky Shuttle.....</b>	<b>233</b>
Thomas E. Riester and Husam (Sam) Gurol	
<i>New System Developments</i>	
<b>Market Trends and Comparative Study of Economic and Technological Parameters of APM Systems .....</b>	<b>245</b>
E. Todt, A. Gehlen de Leão, L. A. Lindau, E. Bortolini, and B. M. Pereira	
<b>Financing Transit Usage with Podcars in 59 Swedish Cities .....</b>	<b>257</b>
Göran Tegnér and Elisabet Idar Angelov	
<b>Sustainability, PRT, and Parking.....</b>	<b>297</b>
Shannon Sanders McDonald	
<b>The Impact of PRT on Army Base Sustainability .....</b>	<b>309</b>
Peter J. Muller	
<b>Ride Sharing in Personal Rapid Transit Capacity Planning.....</b>	<b>321</b>
John Lees-Miller, John Hammersley, and Nick Davenport	
<b>Wireless Communication Based Computer Simulator to Assess the Operational Scenarios for the PRT Systems.....</b>	<b>333</b>
Jun-Ho Lee and Yong-Kyu Kim	
<b>Extending PRT Capabilities.....</b>	<b>343</b>
Ingmar J. Andreasson	
<b>Open-Guideway Personal Rapid Transit Station Options.....</b>	<b>350</b>
Peter J. Muller	
<b>Introducing PRT to the Sustainable City.....</b>	<b>361</b>
Robbert Lohmann and Luca Guala	
<b>The Need for High Capacity PRT Standardization .....</b>	<b>379</b>
Raymond MacDonald	
<b>Vectus PRT Concept and Test Track Experience .....</b>	<b>389</b>
Jörgen Gustafsson and Svante Lennartsson	

### *Plenary*

<b>Defining the Right Roles for Automated Guideway Transit Systems .....</b>	<b>403</b>
Hal Lindsey	
<b>Somewhere in Time—A History of Automated People Movers .....</b>	<b>413</b>
William J. Sproule	

### *System Improvements*

<b>Eco-Industrial Design for Cityval, Siemens' New AGT .....</b>	<b>425</b>
Marc Zuber	
<b>Guideway Design and Construction .....</b>	<b>428</b>
Brian K. Adams, John A. Heath, and Gary B. Lineback	
<b>How to Design a PRT Guideway .....</b>	<b>436</b>
J. Edward Anderson	
<b>Heathrow PRT Guideway, Lessons Learned .....</b>	<b>450</b>
A. D. Kerr and R. J. Oates	
<b>New Technology Integration for Older System Technologies .....</b>	<b>471</b>
Steven M. Castaneda	
<b>Optimizing APM Failure-Mode Capacities.....</b>	<b>484</b>
James W. Green	
<b>Orlando APM Running Surface Rehabilitation: Airsides 1 and 3.....</b>	<b>492</b>
Sambit Bhattacharjee, Dan McFadden, and Tuan Nguyen	
<b>System Demonstration: Preparing for Success.....</b>	<b>499</b>
Matthew Sturgell	
<b>Energy-Efficient APM Using High Performance Batteries .....</b>	<b>507</b>
Masaya Mitake, Hiroshi Ogawa, and Katsuaki Morita	
<b>Standards for Successful APM Implementation.....</b>	<b>511</b>
Frank Culver and Mario Nuevo	
<b>Advanced Composite Carbody Systems.....</b>	<b>525</b>
Takaomi Inada, Genichirou Nagahara, Seung-Cheol Lee, Dae-Hwan Kim, Masaaki Kuwabara, and Tsutomu Hoshii	
<b>Advances in Passenger Convenience and Comfort.....</b>	<b>534</b>
Kunihiro Tatecho, Masafumi Kawai, Yuji Koike, Motoaki Tanaka, Masaaki Kuwabara, and Tsutomu Hoshii	

### *Urban Metro*

<b>Objectively Assessing Automatic vs. Manual Control for Transit Systems.....</b>	<b>546</b>
John E. Joy	
<b>Rubber Tired APM—A Better Solution for Honolulu Rapid Transit .....</b>	<b>555</b>
J. David Mori	
<b>Guangzhou APM: First Urban APM in China .....</b>	<b>562</b>
Rob DeCoster	



**Simulation Analysis of APM Systems in Dense Urban  
Environments— Part 1: Transit User Experience..... 574**  
J. Sam Lott, Douglas Gettman, and David S. Tai

**Simulation Analysis of APM Systems in Dense Urban  
Environments— Part 2: System Operations..... 588**  
J. Sam Lott, Douglas Gettman, and David S. Tai

**An Enhanced Bombardier CX-100 APM Vehicle..... 603**  
Jack Galanko and Scott Moore

*Indexes*

**Author Index..... 621**

**Subject Index..... 623**

## **Landside APM Planning at Seattle-Tacoma International Airport**

**Dave Tomber<sup>1</sup>, Harley Moore<sup>2</sup>, and Bob Griebenow<sup>3</sup>**

<sup>1</sup>Aviation Planning Manager, Port of Seattle, Seattle-Tacoma International Airport, P.O. Box 68727, Seattle, WA 98168-0727; PH (206) 444-4368; FAX (206) 431-4496; email: [tomber.d@portseattle.org](mailto:tomber.d@portseattle.org)

<sup>2</sup>Senior Principal, Lea+Elliott, 785 Market Street, 12th Floor, San Francisco, CA 94103, PH (415) 908-6450, FAX (415) 908-6451, email: [hlmoore@leaelliott.com](mailto:hlmoore@leaelliott.com)

<sup>3</sup>Vice President, Berger ABAM, 33301 9th Ave S, Suite 300, Federal Way, WA 98003-2600, PH (206) 431-2323, FAX (206) 431-2250, email: [bob.griebenow@abam.com](mailto:bob.griebenow@abam.com)

### **ABSTRACT**

Increasingly, large-hub airports in the United States (U.S.) are developing rental car facilities remote from their terminals in a facility that consolidates the operation of all rental car companies. In many U.S. large-hub airports, the percentage of passengers using rental cars is a significant percentage of overall traffic. At Seattle-Tacoma International Airport (SEA), almost 20% of all passengers use rental cars, creating a need for a transportation system that can move large volumes of people and baggage in peak periods with reliable frequencies and both reliable and minimal transit times. This paper is a case study for a landside automated people-mover (APM) system at SEA. It explores issues related to the feasibility of installing an APM system at SEA between the main terminal and a future consolidated rental car facility remote from the terminal. It analyzes the trade-offs between busing and different APM systems.

### **BACKGROUND**

Seattle-Tacoma International Airport (SEA) served 32 million passengers in 2008. Forecasts indicate that this passenger activity could grow to almost 60 million annual passengers over the next 20 years. SEA is predominantly an origin-destination airport: in 2008 about 80% of the passengers started or ended their journey at SEA. This high concentration of origin-destination activity places heavy demands on landside facilities, such as airport roadways, curbsides, parking, and various ground transportation modes.

Increasingly, large-hub airports in the United States (U.S.) are developing rental car facilities remote from their terminals in a facility that consolidates the operations of all rental car companies. SEA began construction of a remote consolidated rental car (CONRAC) facility in 2008. The CONRAC site is located approximately 1 mile north of the existing terminal. An APM guideway connecting the existing terminal to the remote CONRAC needed to be planned to cross over a regional light rail system, also under construction in 2008 and scheduled to be completed by early 2010. A further planning constraint is that envelope of the APM vehicle height needs to be under airspace navigational ceilings determined by the Federal Aviation Administration (FAA) for interaction with arrival and departure aircraft flows from nearby King County Airport.