MONASH University

Driving Growth in Light Rail
Radisson Blue Plaza Hotel Sydney
Wednesday 27th July 2016

International Developments in Light Rail Transit Design & Planning

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Monash University

PTRG PUBLIC TRANSPORT RESEARCH GROUP

GROUP OF EIGHT AUSTRALIA

ITS (Monash)

Institute of Transport Studies (Monash)
The Australian Research Council Key Centre in Transport Management

MONASH University

Introduction

Nouveau Tramway France

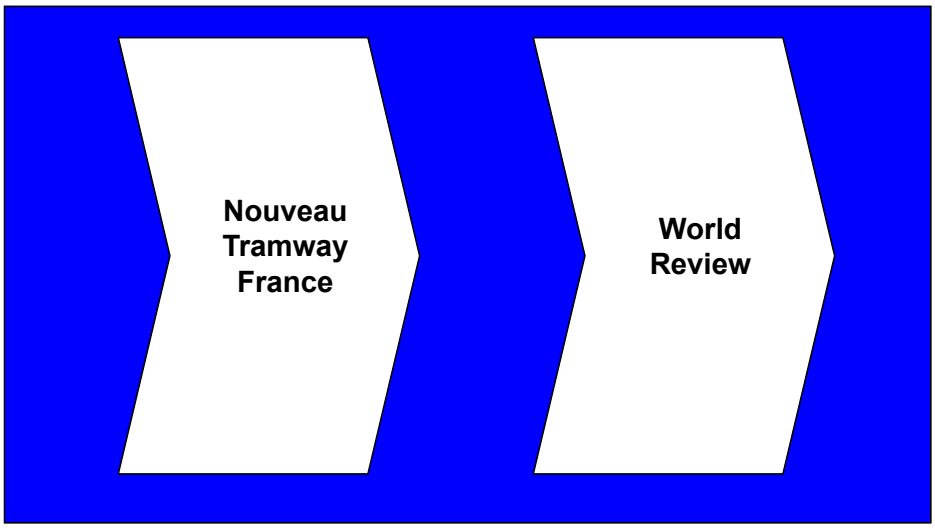
World Review

PTRG PUBLIC TRANSPORT RESEARCH GROUP

Paper aims to review new developments in Light Rail

- Purpose is to understand current developments and new ideas
- Focus is:
  - Design
  - Planning
  - Technology
- The basis of the review is the authors research and visits to systems undertaken in 2015/16 as part of activities for the US Transportation Research Board and Monash University

...and is structured as follows



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Introduction

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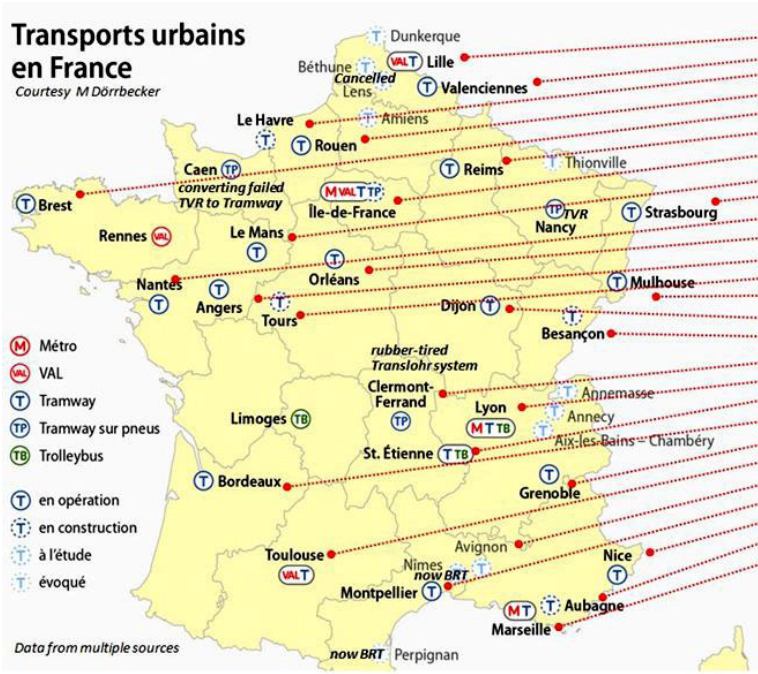
The largest world LRT development has been the Nouveau Tramway movement in France

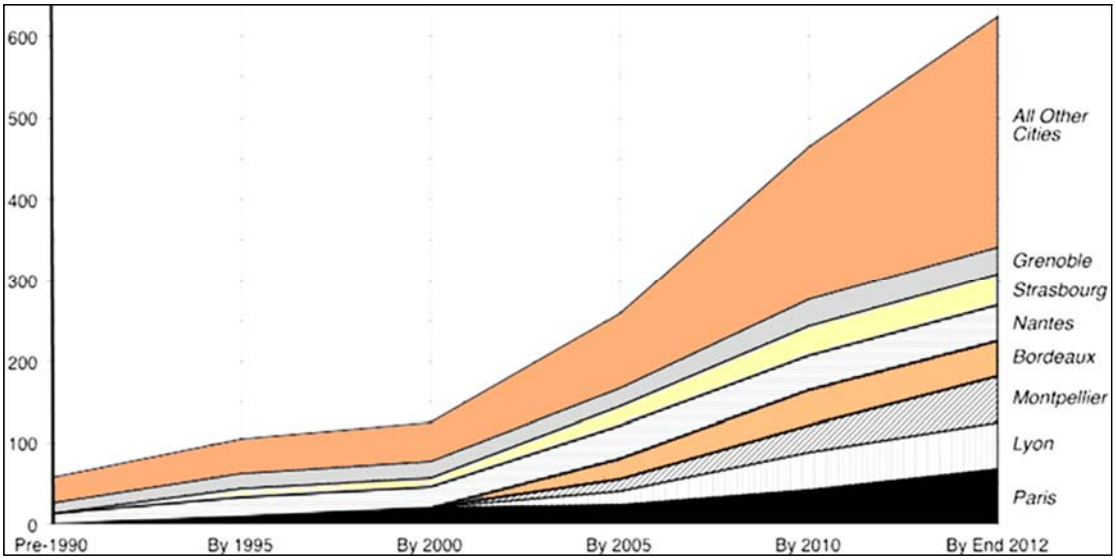


City	Population	Opened	Lines	km	pax/day
Lille	1,100,000	1994	2	22.4	32,000
Valenciennes	400,000	2006	1	18.3	33,000
Le Havre	610,000	2012	2	13	new
Rouen	530,000	1994	2	15.1	65,000
Brest	220,000	2012	1	14.3	new
Reims	290,000	2011	2	16.1	45,000
Paris	11,800,000	1992	4	41.4	315,000
Le Mans	150,000	2007	1	15.4	48,000
Strasbourg	640,000	1994	6	57.2	300,000
Nantes	800,000	1985	3	42.1	266,000
Orléans	120,000	2000	1	17.9	45,000
Angers	280,000	2011	1	12.3	35,000
Tours	300,000	2013	1	15.3	new
Mulhouse	250,000	2006	4	41.8	60,000
Dijon	250,000	2013	2	20	new
Besançon	140,000	2015	1	14.5	new
Clermont-Ferrand	260,000	2006	1	14.2	48,000
Lyon	1,760,000	2000	5	72.1	250,000
St-Etienne	320,000	1991	3	22.5	70,000
Bordeaux	1,010,000	2003	3	43.4	350,000
Grenoble	530,000	1987	4	36.4	210,000
Toulouse	1,100,000	2010	1	10.9	20,000
Avignon	90,000	2016	2	14.5	new
Montpellier	530,000	2000	5	54.4	282,000
Nice	350,000	2007	1	8.7	90,000
Aubagne	100,000	2014	1	9	new
Marseille	1,530,000	2007	1	11.5	87,000

700 kilometers of double-track on 65 routes serving 25 million people in 30 cities with 1200 trams/LRVs

...during the Global Financial Crises...

Growth of French Tramways—kilometres of route



...using an integrated street design and transit design concepts

Including MACRO and MICRO design principles

Nouveau Tramway Principles

MACRO Design Principles

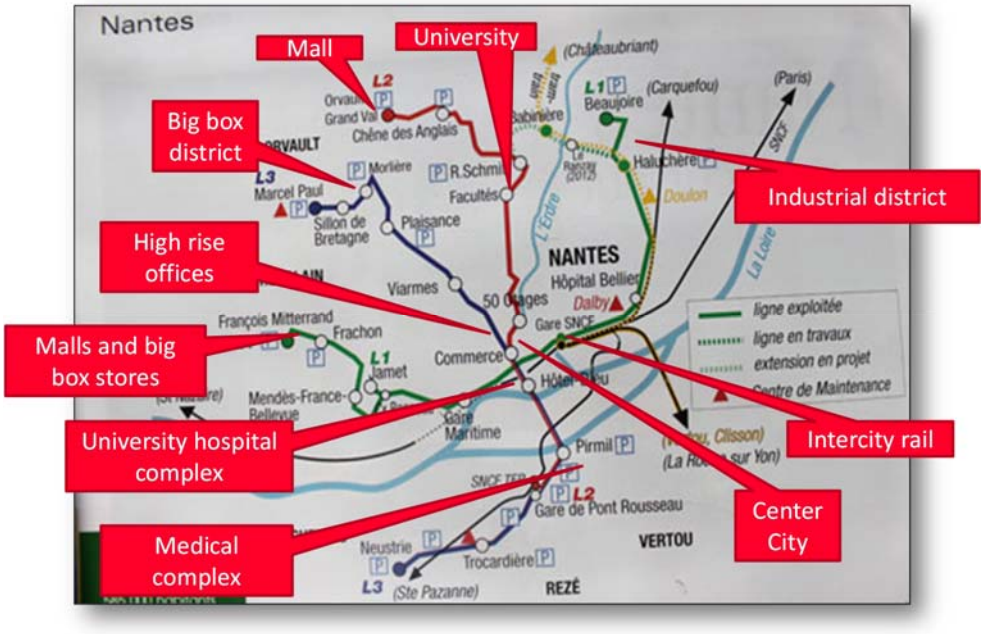
- Develop a a concept of how public transport should tie the urban agglomeration together: a small number of light rail (nouveau tram) and/or BRT lines is key
- High-performance and -capacity vehicles designed to blend with the urban fabric and facilitate accessibility between lines and modes
- Fully accessible stops widely spaced
- Stops adjacent to ,and integrated with major destinations; including in suburbs
- Local bus lines reconfigured around nouveau tram or BRT stations

MICRO Design Principles

- Almost 100% use of public rights-of-way
- At the expense of the auto, which are kept off tracks
- Examples: Roads, alleys, plazas, university campuses, hospital campuses
- All rights-of-way rebuilt from building façade to building façade to facilitate transit performance, pedestrian and bicycle flow, safety, aesthetics
- The Art of Insertion is a political process wherein stakeholder groups figure out how to design high performance transit that is compatible with their lifestyles

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MACRO Design Principle 1: A Regional Core of Light Rail or BRT Lines



Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MACRO Design Principle 2: Long vehicles with lots of doors and a fare system that allows passengers to use all doors, bright, cheery, airy

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MACRO Design Principle 3: Fully accessible stops spaced widely to enable faster service

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MACRO Design Principle 4: Stops adjacent to major destinations; many in suburbs

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MACRO Design Principle 5: Bus system reconfigured around light rail stops

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion Center City insertion where two lines cross

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion Center City - High traffic street becomes pedestrian mall with LRT

Before

After

Source: www.publicspaces.org
Location : Rue des Frances Bourgeois, Strasbourg

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Center City - High traffic street becomes pedestrian friendly with LRT

Before

After

Source: Marc Le Tourneur, Veolia Transdev
Location : Place Broglie, Strasbourg

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Center City - High traffic street becomes pedestrian plaza with LRT

Before

After

Source: H. Guyot, CEO Connexxion, VTD Netherlands
Location : Place de Homme de Fer, Strasbourg

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Transit Plaza

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Insertion into an alley

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Insertion into an alley

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Angers: Edge of center city

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Stop shoe-horned into tight spot

Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

MICRO Design : The ART of Insertion - Stopping trains delay autos; not vice versa

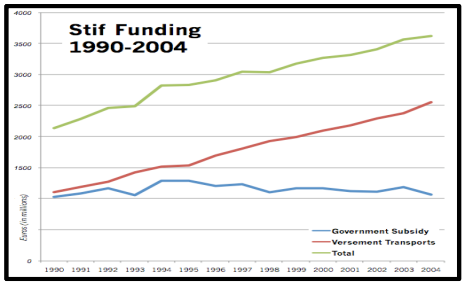
Source: Thompson G Currie G and Parkinson T (2016) 'Structural Transit Streets: The French Approach ...and thoughts for America' Designing Streets for Transit – 95th Transportation Research Board Annual Meeting, Washington DC January 10th 2016

Versement Transport – flexible funding with deeper pockets for bigger projects

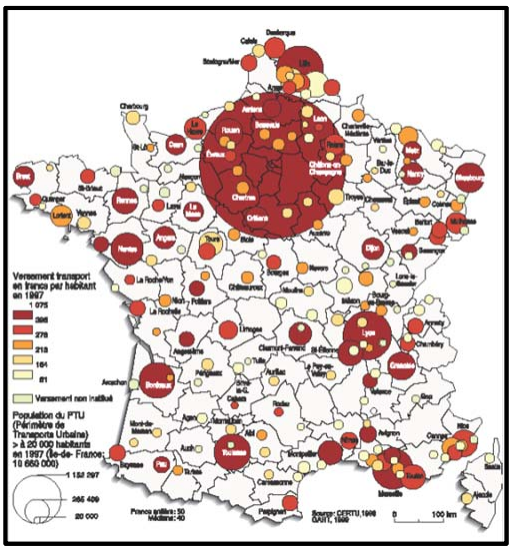
Versement Transport

- A payroll tax - levied on the wages provided by all businesses with 10 or more employees within a transport authority region
- Usually 1% of payroll but can be higher if a good case to improve mobility is made e.g. Reims 1.8%
- Covers Capital and Operating Costs
- Can be sensitive to economic performance

Funding Source - STIF Paris 1990-2004



VT Per Capita Funding (1997)



Source: Parkinson T and Currie G (2012) 'Drivers of French Light Rail Success: Preliminary Findings' State-of-the-Art Light Rail: Lessons from France, TRB 91th Annual Meeting 22-26 January 2012, Washington, DC, USA

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Introduction

Nouveau Tramway France

World Review

Portland, Oregon; The Tilikum Crossing

Portland, Oregon; Streetcar

Out West USA: Streetcars

Smart Transit agencies think outside the box – Uber/Car Share and LRT

Transit runs the Car Share Scheme

Source: Currie G (2015) 'The Uber Verdict'

Trams enter Den Haag Centraal Station in the Netherlands through large openings in the facades…

Source: http://www.dezeen.com/2016/02/17/benthem-crouwel-den-haag-centraal-station-hague-netherlands-patterned-glass-roof/

…Light rail is elevated while heavy rail is at-grade

Source: http://www.dezeen.com/2016/02/17/benthem-crouwel-den-haag-centraal-station-hague-netherlands-patterned-glass-roof/

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Source: http://www.dezeen.com/2016/02/17/benthem-crouwel-den-haag-centraal-station-hague-netherlands-patterned-glass-roof/

Bombardier has unveiled a new 3D optical sensor system to assist tram drivers in detecting obstacles…

- Developed in association with the Austrian Institute of Technology in Vienna
- Can accurately monitor the path in front of the vehicle to a distance of more than 60 metres while automatically identifying potential hazards
- Rolled out to the entire range of Bombardier trams
- First operations in Marseille, France

Source: http://www.railway-technology.com/news/newsbombardier-unveils-new-optical-3d-sensor-system-tram-safety

… is a future of driverless LRVs feasible?

Catenary Free Operations

Source: Messelyn C (2012) 'Designing Trams to Service Historic Districts with Speed, Capacity and Elan'
State-of-the-Art Light Rail: Lessons from France, TRB 91th Annual Meeting 22-26 January 2012, Washington, DC, USA

Traction battery-powered tram – Nice France

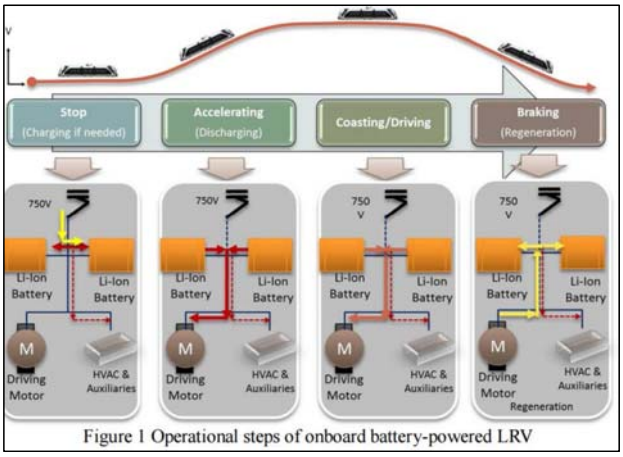


Figure 1 Operational steps of onboard battery-powered LRV

Benefits

- Greater operational range than super-capacitors.
- Significantly cheaper than super-capacitors.
- Do not use fossil fuels and improve air quality along lines.
- Do not require expensive third rail technologies such as electrified ground rails.
- Safer than third rail electric power transfer.
- With recent battery technology improvements, able to reduce long-term catenary maintenance costs significantly

Issues

- Longer recharge times compared to other forms of on-board storage such as super-capacitors and fuels.
- Higher initial purchase price for rolling stock.
- Often require regular unit replacement due to short life cycles.
- Funding sources relatively poor for battery-only trams worldwide
- Batteries have relatively limited range (although only designed for 500m sections of catenary-free track).
- Newer battery technologies are being developed at an accelerated pace, making current NiMH systems appear inefficient in relative terms.

Source: Sintropher (2015) 'Innovative Technologies for Light Rail and Tram: A European reference resource' Briefing Paper 4 Traction Battery – NiMH & Primove Systems Sept 2015 University College London

PRIMOVE Li-ion Battery : Nanjing China

Benefits

- PRIMOVE batteries are able to recharge quickly via pantograph at tram stops and through some acceleration points, allowing for a 90% catenary-free system.

Issues

- Technology is relatively new and has higher engineering costs than some other catenary-free systems.
- Battery lifespan not fully tested, could lead to regular replacement on high-traffic lines

Source: Sintropher (2015) 'Innovative Technologies for Light Rail and Tram: A European reference resource' Briefing Paper 4 Traction Battery – NiMH & Primove Systems Sept 2015 University College London

PRIMOVE Li-ion Battery : Nanjing China

Super-capacitor LRVs are being introduced in Guangzhou, China…

- Catenary-free tram technology
- Evolved from battery powered trams as an alternative method of energy storage and capture
- Trams are able to run up to 4km between charging
- Onboard supercapacitors automatically charged at stops; takes 10-30 secs

Source: http://www.railwaygazette.com/news/urban/single-view/view/guangzhou-supercapacitor-tram-unveiled.html

…with hybrid systems (super-capacitor & battery) operating in Seville, Spain…

Source: http://www.polisnetwork.eu/publicdocuments/download/1765/document/nimh-and-primove-systems-2---finalpolis.pdf

…and also in Almada-Seixal, Portugal

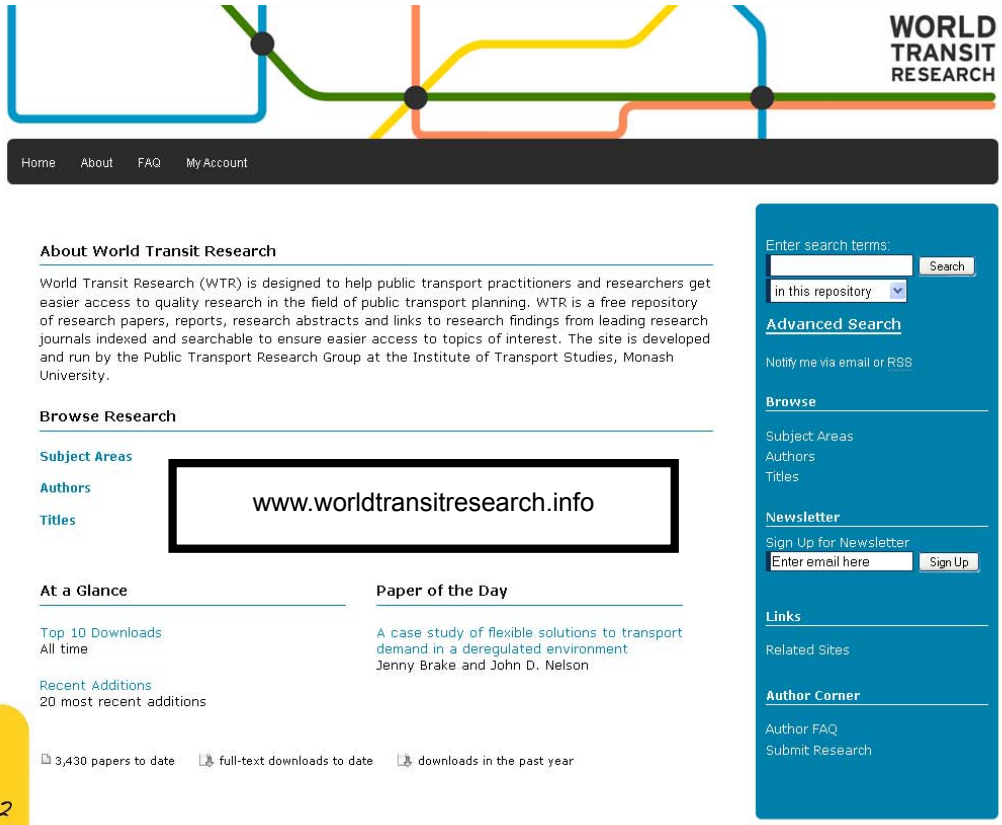
Source: http://www.polisnetwork.eu/publicdocuments/download/1765/document/nimh-and-primove-systems-2---finalpolis.pdf

Safety Initiatives

A disturbing video:

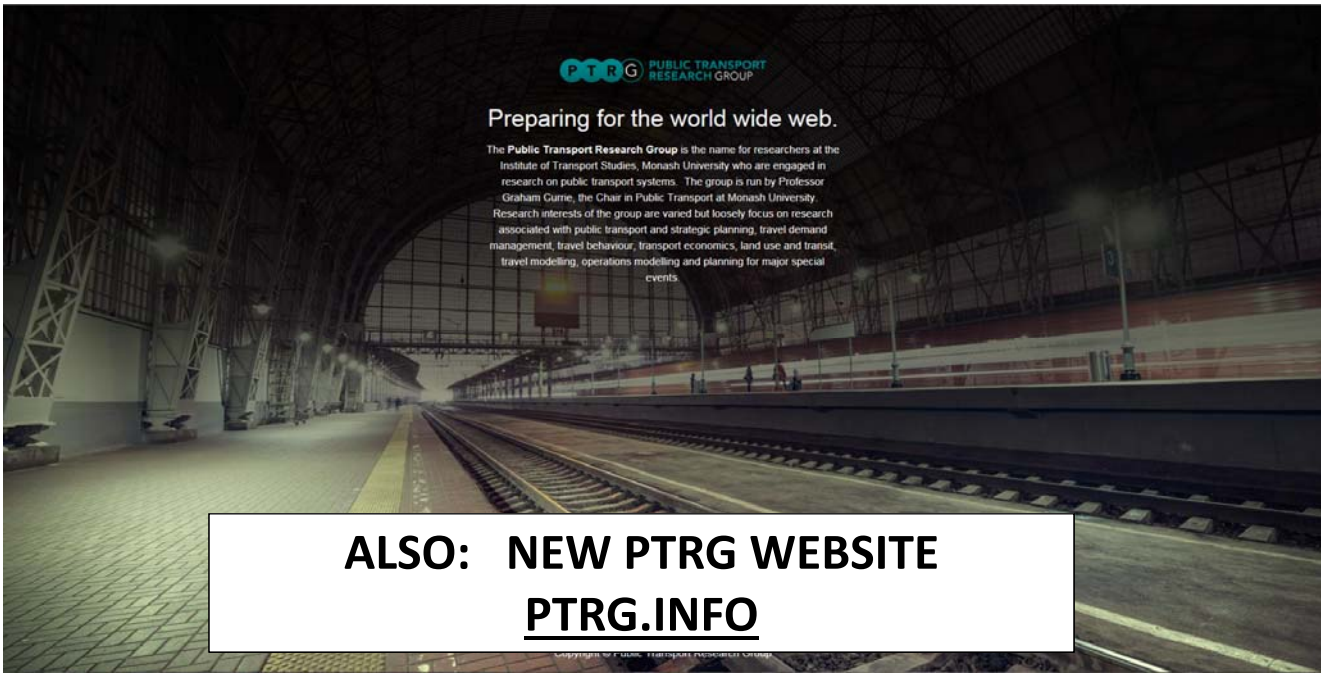
New ideas in LRT safety systems

New ideas in LRT safety systems



2025=PTx2

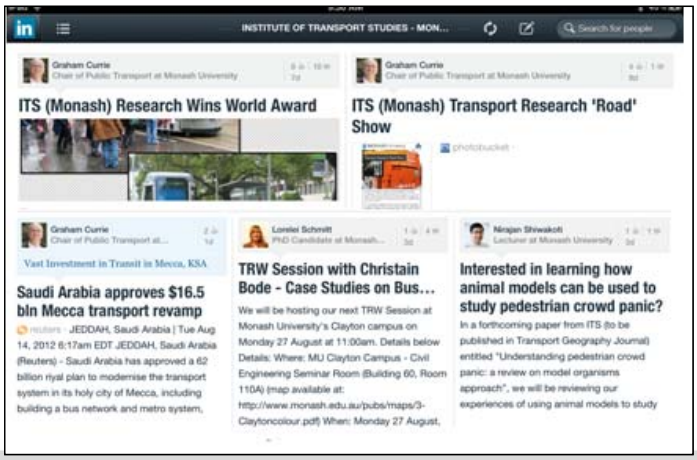
Showcase Award Winner

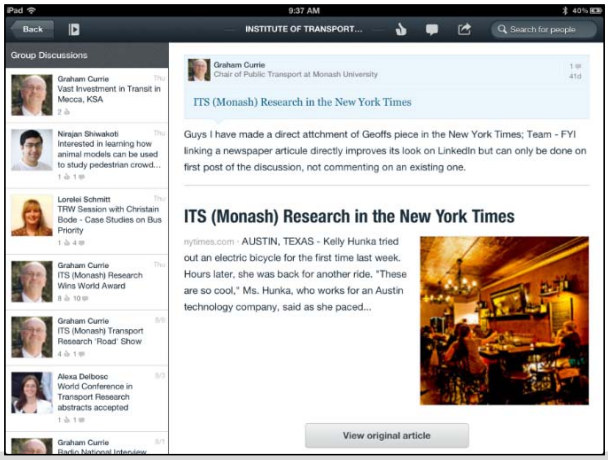


ALSO: NEW PTRG WEBSITE

PTRG.INFO

Join the **ITS (Monash)** LinkedIn group to keep informed of our activities





Planning Public Transport Services – Short Course Melbourne 15-18 August, 2016