Optimization of the network design of a futuristic transport system based on accelerated moving walkways

Riccardo Scarinci  Bastien Rojanawisut
Iliya Markov  Michel Bierlaire
Guillaume Lopez  Jianghang Chen

Transport and Mobility Laboratory TRANSP-OR
École Polytechnique Fédérale de Lausanne EPFL
Moving walkway, Exposition Universelle, Paris 1900
Context

Post-Car World

No use of private car

• Redistribute the “future” demand on a mix of transport systems
Research idea

**Accelerated Moving Walkway (AMW)**

A network of Accelerated Moving Walkway in urban area
Contents

• Accelerated Moving Walkway (AMW)
  • Implementation examples
  • System description
• Optimization of a network of AMW
  • Decision variables
  • System parameters
  • Objective function and constraints
• Results
• Conclusions
Accelerated Moving Walkway
Accelerated Moving Walkway
Accelerated Moving Walkway

Implementation examples

**TurboTrack Toronto**
- Entry speed: 2.3 km/h
- High speed: 7.2 km/h
- Length: 270 m

**Gateway Paris**
- Entry speed: 2.2 km/h
- High speed: 9 km/h
- Length: 185 m

AMW could be competitive with urban public transport and private cars (average speed of 15 km/h)
Accelerated Moving Walkway

System description in a quantitative form
Optimization of a network of AMW
Optimization of a network of AMW

Conceptual example
Optimization of a network of AMW

Intersection design

Practicality
Preferred directions

Permeability
Urban integration
Accessibility
Perception
etc..

Images: Rojanawisut
Optimization of a network of AMW

Decision variables and criteria

Decision variables:

- $y_i$ equipped or not
- $x_i^a$ acceleration section
- $z_i$ width of the walkway

Objectives:

- Min. travel time
- Max. speed
- Max. comfort
- Min. energy consumption
Optimization of a network of AMW

Criteria – mathematical formulation example

- Travel time

\[
TT_i = 2t_a + t_c = \frac{1}{a} \left( \sqrt{v_0^2 + 2ax_i^q} - v_0 \right) + \frac{l_i - 2x_i^q}{\sqrt{v_0^2 + 2ax_i^q + v^w}}
\]
Optimization of a network of AMW

Optimization concept

Locate the highest top while blindfolded.

Space: all possible configurations of AMW network
Elevation: objective, i.e. max speed
Optimization of a network of AMW

Objective function

Objective function:

\[ f_i = y_i(w_1 TT_i + w_2 d_i + w_3 e_i + w_4 c_i^c + w_5 c_i^o) + (1 - y_i)w_6 l_i/v^w \]

Subject to constraints:

\[ v_i^1 \leq v_{\text{max}} \quad \sqrt{v_0^2 + 2ax_i^a} \leq v_{\text{max}} \quad x_i^a \leq l_i/2 \]
Results
Results

City network

Nodes

Links
Results

City network

Origin

Destination
Results

Optimization algorithm

Objective:
Min. Total Travel Time

Constraint:
Budged for 10 AMW
Results

Optimization algorithm

Initial solution

Assignment

- O/D
- Path
- Flow

Objective evaluation
Results

Optimization algorithm

Intelligent searching algorithm

2nd iteration
Results

Optimization algorithm

3rd iteration

Convergence
Results

Optimization algorithm

![Graph showing Total Travel Time vs Iteration](image-url)
Conclusions
Conclusions

Assumption: a world without private cars

free to investigate innovative mean of transport as part of the future modal mix (reusing urban space)

• Review of Accelerated Moving Walkway (AMW)
• Definition of the optimization problem, decision variables, system parameters, objective function and constraints
• Investigation on the practicality of this system from a transportation point of view
Thank you for your attention

Riccardo Scarinci
riccardo.scarinci@epfl.ch

Transport and Mobility Laboratory TRANSP-OR
École Polytechnique Fédérale de Lausanne EPFL