Which evolution and technological solutions for sustainable land transport systems / Quale evoluzione e soluzioni tecnologiche per i trasporti terrestri sostenibili

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Quale evoluzione e soluzioni tecnologiche per i trasporti terrestri sostenibili

Which evolution and technological solutions for sustainable land transport systems

Politecnico di Torino, Dip. DIATI-Trasporti

15.11.2018
1. How are mobility and traffic evolving, in general?
2. What do mobility and logistics ask for today, in terms of general trends?
3. Which are the constraints – namely in terms of sustainability (CC) - for transport systems in this 1st half of XXI century?
4. The expected solutions for transport within urban contexts
5. The expected solutions for extra-urban transport systems

The conclusions resume the technological solutions that can be expected according to the premises, therefore compliant with present and expected environmental constraints and goals.
1/6 How are mobility and traffic evolving?

- Trends during last century and beginning of the XXI
- Motionless communications
- Daily use of automobiles

- Population
- Supply: road, rail transport
Source: ITF statistics; the high estimate for the USA assumes car occupancy rates remain at the level measured in 2001, and the low one that they decline as of 2001 to the level observed in the most recent household travel survey.
Idle time after finishing a trip for all the driving cycles.

Frequency [#days] of the daily distance covered over all the driving cycles (contexts) for all the trips.

What do mobility and logistics ask for today
- Efficiency
- Quality
- Safety-security

- “Green” (hybridisation, decarb./electrif., well used PT)
- Connected vehicles, flexible modal choice
- Assisted driving, transport systems operating on fixed guideways
¾ of European population:

- Rural contexts
- Metropolitan contexts
- Populat. in urban centers

for transport: 94% toe from crude oil in EU

>½ of global consumption of crude oil

from primary energy sources

1/5 of global consumption of energy

1/6 emissions from human activities → 1/3 in 2018

Transport systems

Environment

Transport and energy use

3/6 Constraints for transport systems in this 1st half of XXI century

- European, in general
- European, automotive
- European, urban pollution
Transport and emissions: general situation EU in various fields (not only transport systems)

CO₂
-40% on 1990 levels by 2030

Renewables
27% by 2030
(some inputs also on 30%)

Energy efficiency
27% by 2030
(some inputs up to 38% at 2050)

EU, 24.10.2014: constraining values at European level, indicative at national level; substitute previous target 20-20-20
UE - Emissioni medie CO2 delle vetture nuove immatricolate
EU - Monitoring CO2 emissions from new passenger cars

2013 is the first year when the average CO2 emissions are below the 2015 emissions target.
Figure 3. Comparison of global CO₂ regulations for new passenger cars.⁰
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Concentration</th>
<th>Averaging period</th>
<th>Legal nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine particles (PM2.5)</td>
<td>25 µg/m³</td>
<td>1 year</td>
<td>Limit value entered into force 1.1.2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limit value enters into force 1.1.2015</td>
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<tr>
<td>Sulphur dioxide (SO2)</td>
<td>350 µg/m³</td>
<td>1 hour</td>
<td>Limit value entered into force 1.1.2005</td>
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<tr>
<td></td>
<td>125 µg/m³</td>
<td>24 hours</td>
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<tr>
<td>Nitrogen dioxide (NO2)</td>
<td>200 µg/m³</td>
<td>1 hour</td>
<td>Limit value entered into force 1.1.2010</td>
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<tr>
<td></td>
<td>40 µg/m³</td>
<td>1 year</td>
<td>Limit value entered into force 1.1.2010*</td>
</tr>
<tr>
<td>PM10</td>
<td>50 µg/m³</td>
<td>24 hours</td>
<td>Limit value entered into force 1.1.2005**</td>
</tr>
<tr>
<td></td>
<td>40 µg/m³</td>
<td>1 year</td>
<td>Limit value entered into force 1.1.2005**</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.5 µg/m³</td>
<td>1 year</td>
<td>Limit value entered into force 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and 1.0 µg/m³ limit value applied from 1.1.2005 to 31.12.2009)</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>10 mg/m³</td>
<td>Maximum daily 8 hour mean</td>
<td>Limit value entered into force 1.1.2005</td>
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<tr>
<td>Benzene</td>
<td>5 µg/m³</td>
<td>1 year</td>
<td>Limit value entered into force 1.1.2010**</td>
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<tr>
<td>Ozone</td>
<td>120 µg/m³</td>
<td>Maximum daily 8 hour mean</td>
<td>Target value entered into force 1.1.2010</td>
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<td>Arsenic (As)</td>
<td>6 ng/m³</td>
<td>1 year</td>
<td>Target value enters into force 31.12.2012</td>
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<tr>
<td>Cadmium (Cd)</td>
<td>5 ng/m³</td>
<td>1 year</td>
<td>Target value enters into force 31.12.2012</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>20 ng/m³</td>
<td>1 year</td>
<td>Target value enters into force 31.12.2012</td>
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<tr>
<td>Polycyclic Aromatic Hydrocarbons</td>
<td>1 ng/m³</td>
<td>1 year</td>
<td>Target value enters into force 31.12.2012</td>
</tr>
</tbody>
</table>

4/6 Expected transport solutions for urban contexts
Some European cities, 1900

Paris

London

Same cities, today

A REACHED **AIM**
OF THE EUROPEAN SOCIETY

DIFFUSED **MOTORISATION**

Nowadays frequently REGULATED, CONTROLLED, ELECTRIFIED (fixed guideway)
Some EU cities, today

**FUTURE AIMS OF SOCIETY**

QUALITY, SAFETY, SECURITY, EFFICIENCY

**Technological solutions**

- Automated Undergrounds ($> \sim 10 \text{ k pp/h \times d}$)
- and People Movers ($< \sim 10 \text{ k pp/h \times d}$)
- Flexible mobility through Intelligent transport systems (ITS)
- More oil-independent vehicles and green motor vehicles
  - *including sharing*
Practical example: VAL Torino (ex. for the effects of the lengthening of the line of the attracted traffic)

Passengers:

- 2006 (*Fermi-XVIII Dicembre*): 7 million 880 k pp
- 2007 (extension to *Porta Nuova* from Oct.): 12 million 433 k pp
- 2008: 20 million 509 k pp
- 2015: 41 million 119 k pp

5/6 Expected transport solutions for extra-urban contexts
Records and maximum speeds on railways

I period:
- Birth of railways
- Large investments
- Sudden development

II period:
- Reduction in investments and world wars
- Record in 1955: need for a new engineering and design approach

Maximum speed operating on railways

- 331 km/h
- 574.8 km/h (2007)

High speed and fast transport by train


Dispense di «Sistemi di trasporto ferroviari, metropolitani e a fune», Politecnico di Torino, 2018
Specific energy consumption HSR (High speed Rail) vs air transport for different route lengths (PASSENGERS)

Extra urban context: a practical example

1/3 du trafic national français

Des liaisons transeuropéennes importantes avec l'Espagne, l'Italie & le nord de l'Europe

240 trains par jour en moyenne sur le tronçon le plus chargé, dans les 2 sens

44,4 millions de voyageurs en 2017

Plus de 460 km de voies

37 ans de service depuis 1981
Extra urban context:
a practical example
Torino-Milano, HSR (ex. for the effects of the lengthening of the rail line AV on the supply and demand)

- December 2009 – 7 couple of HST in week days
  4 of these continuing towards Rome, with stop in Milan Porta Garibaldi, the others at Milan Centrale. On Saturdays 3 couples, 5 on Sundays

Distributed traction power:
- More power with the same axle load
- Better traction control
- Longer and heavier trains (35 wagons - 750 m, even on steep lines)

Active control of the whole train:
- Active traction control
- Braking control and modulation
- Control and power supply of secondary devices and plants besides cargo (refrigeration)

Supervision of the whole train:
- Supervision of the wagons sub-systems
- Supervision of the traction and braking sub-systems
- Wheelset supervision

- Higher speed with the same load
- Possibility to be used on HS/HC lines besides traditional railways (long trains)
- Better energy performances (better running profiles)
- Supervision of the electrical, mechanical and pneumatic sub-systems (improved maintenance)
- Cargo supervision
- Cargo refrigeration
Growth

Time

1880
1940
1990
2020

Onerous motionless communication
Connected and green automobiles
Re-inventing business
Traditional automobiles
Cheap motionless communication and no alternatives to oil derived fuels for cars

Car 1890
Car, 1st half of XX c.
Car, since 40s' in US and 50s' in Europe
Car, since late 80s and 90s'

Concept creation
Concept development
Market development
Business optimisation
Door-to-door travel time

Dispense di «Sistemi di trasporto ferroviari, metropolitani e a fune», Politecnico di Torino, 2018
Therefore... (Conclusions)
A. A European rail network of medium-big cities in a hierarchical co-modal EU network

- **Mega-cities**
  - burn land
  - depreciate land already used
- “Stop” to the use of land for constructions
- A HSL rail network for medium-cities
- Air/train HUBs for VLD by airplane
B. A EU network of rail terminals (inland-ports-industries)

- freight EMUs
- HDV with ICE and PHEV/HEV for mixed use
C. **Flexible co-modality in cities**

(1\textsuperscript{st} feasible step against global warming)

- PHEV (Plug-in hybrid electric automobiles)
- Electric vehicles when each night the depot or parking is fixed
- Sharing (PT included); bikes
- MAAS
Grazie per l’attenzione
Thank you

Bruno DALLA CHIARA
Politecnico di Torino
Dept. DIATI-Transport systems
bruno.dallachiara@polito.it