Dr. Clemente Fuggini, PhD, is a civil engineer specialized in structural monitoring, structural control, smart structures and systems, reliability analysis and numerical models. Clemente has worked for D’Appolonia S.p.A. since 2009 being involved in different projects in the area of transport, construction and security. In Sustrail, he serves as assistant project coordinator as well as main contact point for D’Appolonia (TRAIN) activities in WP3, WP4 and WP8.
Sustrail Project
An Integrated Approach in Freight Rail

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Motivations and Aims

Freight transport volumes are expected to grow by 38% by 2030.

A modal shift of freights from road to other transport mode (rail and waterborne) of 30% by 2030 is needed.

Congestion is becoming unsustainable. Moving freight by road is one of the main causes.

Changes are needed, necessary, opportunistic.

EU27 rail freight forecasts, 2005 & 2050 market share (TRANSvisions, 2009)

<table>
<thead>
<tr>
<th></th>
<th>%tkm 2005</th>
<th>%tkm 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Road</td>
<td>47</td>
<td>40</td>
</tr>
<tr>
<td>%Rail</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>%Maritime</td>
<td>41</td>
<td>42</td>
</tr>
</tbody>
</table>
Sustrail at a glance

- In this scenario, Sustrail was launched on June 2011 aiming at *improving sustainability & competitiveness of railway freight*, taking a whole system approach (vehicle+track) to allow freight to run at higher speed,
A systemic Approach

- Novel design materials for lightweight high performance freight vehicles, bogies and brake systems
- Improvements in braking and suspension design
- Advanced vehicle dynamics, including new wheels profile for a low impact freight vehicle
- Optimised of track system design and geometry coupled with low impact vehicle. Track condition monitoring to reduce track degradation
- Demonstration of technological solutions
- Investigation of economics impacts LCC and RAMS under the project Pillars of Sustainability, Competitiveness, and Availability
Routes - benchmarking

• Bulgaria: Serbian Border to Turkey
  – Average train length 500m

• Spain: Mediterranean Corridor from Barcelona to Valencia
  – Electrified, double track, mixed

• UK: Felixstowe and Southampton to Warrington
  – slow lines, stops by passenger service
Priorities & Opportunities

• Criteria:
  – Availability ↑; Costs ↓; Service Quality ↑; Environmental Footprint ↓; Technical Viability

<table>
<thead>
<tr>
<th>Priority Level</th>
<th>Duty Requirements for Improvement</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>1. Modest increase in freight speed (e.g. 120-140kph UK; 100-120kph ES,BG)</td>
<td>whole</td>
</tr>
<tr>
<td></td>
<td>3. Optimise axle load limits (22.5t / 25t / 17-20t)</td>
<td>whole</td>
</tr>
<tr>
<td></td>
<td>7. (20%) reduction in energy used by rail vehicles</td>
<td>vehicle</td>
</tr>
<tr>
<td></td>
<td>12. Requirement for Vehicle Green Label for sustainability performance</td>
<td>vehicle</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EU general</th>
<th>Spain route</th>
<th>UK route</th>
<th>Bulgaria route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target higher freight operating speeds</td>
<td>e.g. 100→120km/h</td>
<td>e.g. 120→145km/h</td>
<td>increase</td>
</tr>
<tr>
<td>Investment in terminals</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gauge enhancement</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Increase axle load capability</td>
<td>✓</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Longer trains</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
The Sustrail Freight Vehicle

- Improved running behavior with reduced environmental impact
  - Optimized Y25 bogie and wheelset
  - Optimized braking system (disc brakes) for noise emission reduction (3db)
  - Increased capacity & lightweight materials

<table>
<thead>
<tr>
<th>SUSTRAIL vehicle specification</th>
<th>Max axle load /T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Max speed /km/h</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>140</td>
</tr>
</tbody>
</table>
The Sustrail Freight Vehicle

- Highlights:
  - SUSTRAIL bogie (Optimized Y25) with:
    - double lenoir links
    - steering links
    - secondary suspension
    - disk brake system

Diagram:
- Spring side bearer
- Crossbeam
- Secondary Suspension Ring
- Lower part of centre pivot bearing
- Brake arm
The Sustrail Freight Vehicle

• Highlights:
  – SUSTRAIL body - Special freight vehicle with bogies (Class S) using:
    • Lightweight materials
      – High strength steel vs. Novel steel profiles
    • Multifunctional solutions (different commodities)
    • Modular design
The Sustrail Freight Vehicle

• How to measure the Sustrail sustainability?
  – Through a “Sustrail Environmental Product Declaration (EPD)”

  – EPD will account for:
    • Technical specifications
    • Environmental impact (CO2)
    • Noise emissions
The Sustrail Track

- Where to impact and what is the aim
  - Maintenance + renewal of a typical railway track and represents 50–60% of the total costs of over its service life
  - Geometry deterioration can even increase it
The Sustrail Track

- Main failures and associated Sustrail “innovations”

| Rail          | • Increase rail cross section (reduce occurrence)  
|              | • Rail grinding (minimize severity) through Improved predictions of RCF damage  
|              | • Improved rail material (reduce occurrence) through the use of premium rail steel  
| Earthworks   | • Slope stabilization (minimize severity) through multifunctional geotextiles  
|              | • Resilient earthworks (minimize severity) through new designs and/or technologies for substructure, validation of previous innovation in the domain  
| Track        | • Geometry monitoring on appropriate frequency (improve detection) through improved methods for geometry degradation prediction  
| S&C          | • Lubrication system (minimize the severity) to improve lubrication regime for slide plates  
|              | • Ultrasonic testing (improve the detection)  
|              | • Improved rail material (reduce occurrence) through Optimised flexibility of S&C  

The Sustrail Track

• The Impact of Innovations (an example)
  – The use of Premium Rail Steel to prevent and reduce rolling contact fatigue (RCF)

– IMPACT

<table>
<thead>
<tr>
<th>What</th>
<th>Which component of the infrastructure</th>
<th>Innovation</th>
<th>technical impact</th>
<th>Infrastructure Manager</th>
<th>Railway Operator</th>
<th>Wagon Owner</th>
<th>Freight Owner</th>
<th>Infrastructure Component Supplier</th>
<th>Wagon Builder</th>
<th>Logistic Service Provider</th>
<th>Freight Handling (terminal operation)</th>
<th>Infrastructure Construction &amp; Maintenance Service Provider</th>
<th>Fleet Maintenance Service Provider</th>
<th>Administration</th>
<th>Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium rail steel</td>
<td>Rail</td>
<td>Premium rail steel - (reduce occurrence)</td>
<td>reduce occurrence of rail fatigue; potential differentiation of track</td>
<td>Infrastructure Manager</td>
<td>Improved reliability of operation due to reduced track maintenance</td>
<td>Improved rail transport service</td>
<td>Improved supply of premium rail steel at an economical price</td>
<td>Improved rail transport service</td>
<td>Adaptation of welding procedures; logistics of various types of rail quality (standard, premium)</td>
<td>Observation of wheel wear behaviour</td>
<td>Approval of differentiated track access charge; approval of adapted maintenance regime</td>
<td>Less rail noise; less emission due to reduced maintenance</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Conclusions

• SUSTRAIL will run until May 2015 aimed at innovations impacting on both infrastructure and vehicles.

Contact us @ www.sustrail.eu

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donato.zangani@dappolonia.it