MORE THAN PROVIDING TRACKS & TRAINS: PROVIDING TRANSPORTATION SOLUTIONS

UNLV Railroad Infrastructure Diagnosis and Prognosis Symposium
Nicolas FLIX, October 2018
More than providing Tracks & Trains : Providing Transportation solutions

1 Introduction

2 The right Rolling Stock for the particular needs of every Railroad Operator

Case of Tilting Trains technology

3 Maintenance performance as project driver from premises
More than providing Tracks & Trains : Providing Transportation solutions

1  Introduction

2  The right Rolling Stock for the particular needs of every Railroad Operator

   *Case of Tilting Trains technology*

3  Maintenance performance as project driver from premises
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Introduction

Key drivers for having Railways business under control

Long Term Profitability, Sustainable Business

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Introduction

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Case of Tilting Trains

Safe, Fast, Cheap, and with the Best Comfort!
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Long Term Profitability, Sustainable Business

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*Competitive Price, Availability, Reliability (Punctuality, Comfort)*

| vs | Acquisition cost, Maintenance cost, Energy cost |

Productive system: more time in service, at a lower cost!

Maintenance Performance

Key drivers for having Railways business under control
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   *Case of Tilting Trains technology*

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Case of Tilting Trains technology

Alstom tilting early history

1969

1970 - 1974
Y0160 1st train order from Italian Railways to FIAT Ferroviaria. 11-Oct-71 first test. 11-Jan-72 2.2 m/s². Same year 248 km/h

1975 June 26th 2 power car first trip.

1976 April 8th Revenue service Rome-Ancona. ETR401 30 min save 250 km/h, 1.8MW, 4car 10° tilting angle

1988 May 29th ETR450 started operating Rome-Milan 57min saving Average 153 km/h 250 km/h, 5MW, 9car 8° tilting angle
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Tilting Principle: Speed gain with enhanced comfort

- Up to 2 m/s² non-compensated acceleration (n.c.a.) at track level
- Up to 30% speed gain in curve
- Perceived 33% less by passenger → more comfort
- 100% more at track level → higher speed in curve

Alstom tilting trains operate within the normal track limits (force, acceleration, etc.)
No need for special track design
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Case of Tilting Trains technology

More than 300 high speed trains TILT with Alstom technology

1970s
1st Pendolino
(Italy)

1980/1990s
ETR 460/470
(Italy)

1996
Acela Express
(US) (bogies)

1998
Virgin WCML
(UK)

1998
ICE-T
(Germany) (bogies & control)

1998
IC 2000 Alaris
(Spain)

2011
ETR610
(Italy, Switz., Germ.)

2010
Allegro
(Finland, CIS)

2007
New Pendolino
(Italy, Switz., Germ)

2004
Pendolino CZ
(Czech Rep)

1999-2000
DTP2 Test Train
(France)

1999
Alfa Pendular CPA 4000
(Portugal)

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Pendolino Titling system is composed of:

- **Bogies fitted with a Tilting Bolster**, supporting the carbody
- **Hydraulic units & actuators**, controlling the tilting bolster
- **Tilting Pantograph** (if installed on a tilting car)
- **Anticipative algorithms (TILTRONIX™)** processed by dedicated electronics, improving passengers comfort compared to a reactive system.
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Case of Tilting Trains technology

**Tiltronix™: Curve prediction without infrastructure devices**

1. **Track recognition**
   - Sensor signals
   - Reference point

2. **Train localization**
   - Prediction of future curves

3. **Anticipation distance**
   - Distance measured since last reference point
   - Predicted distance before next curve

4. **Anticipation of the tilting command**
   - Trigger point

5. **Continuous and smooth control**
   - Tilt immune to track irregularities

The track macro-geometry measurement system (SUT) is equipped with:
- 1 X axis gyroscope → track cant
- 1 Z axis gyroscope → curve radius
- 1 Y axis accelerometer → cant deficiency
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Case of Tilting Trains technology: new ACELA

DTP:
Prototype of Tilting Train with articulated architecture

ACELA Tilting Train:
Proven trains on the NEC

Pendolino Tilting System:
Wide Return of Experience & most advanced technology

NEW ACELA TILTING TRAINSET

→ Articulated trainset
→ Up to 186 mph
→ Tilting Passengers cars,
  Maximum tilting angle ≈ 6.3 degrees
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Case of Tilting Trains technology: new ACELA

Complex carbody kinematics of Pendolino for

**SAFETY**
- Gauge compliance
- Stability: self-centering independently of the load and non-compensated acceleration.

**COMFORT**
- Stability
- Belly-centered rotation (height of the Center of Instant Rotation close to the body center of the passengers)

**TRACK FRIENDLINESS**
Minimum wear related to limited wheel-rail contact force:
- Limited movement of carbody Center-of-Gravity
- Reduction of non-suspended masses
- Low primary suspended masses
- Designed for high cant deficiency
- Reduced bogie rotation stiffness
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Case of Tilting Trains technology

The challenge

During decades Alstom evolved the tilting technology

😊 To guarantee outstanding safety: self-centering architecture…
😊 To improve reliability: high redundancy, onboard autonomy…
😊 To ensure track friendliness: lowest unsprung mass, passive axle orientation…
😊 To ride at maximum speed: we offer maximum n.c.a. possible
😊 To offer best comfort: belly-centered rotation, active control…

So, how can we still improve it ?

😊 There are still few passengers affected by motion sickness if we run slower:
There’s always a population sensible to motion sickness. The occurrence is low in railways, with just a 10-15% increase when running 30% faster on tilting trains.

😊 The new challenge: reduce motion sickness perceived by passengers
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Case of Tilting Trains technology

How to minimize motion sickness?

A combination of the best solutions based on 25 years of experience

- Minimize vibration
- Minimize low frequency movements
- Minimize translational movements
- Improve curve/tilt synchronization

Pendolino & Tiltronix™

Enhanced BOGIES comfort
Optimized structure
Tilting mechanism Belly height centered
Active tilting +Anticipative

A combination of the best solutions based on 25 years of experience
**More than providing Tracks & Trains: Providing Transportation solutions**

**Case of Tilting Trains technology**

**Tiltronix™ is the answer again to motion sickness:**

Even when running faster, Tiltronix can result in less kinetosis occurrence than on non-tilting trains.

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<td>Non Tilting</td>
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<td>Tiltronix anticipative</td>
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Nausea [0-heavy, 10-no]

Tiltronix **medical validation** was performed in October 2009 with 250 people recruited by SBB, 50% of them being known to be **susceptible to Kinetosis** (motion sickness).

Source: SBB, Reisekrankheit (Kinetose / Motion sickness), Befragungen im Rahmen des Projekts „Bogenschnelles Fahren“, Nov 2009
Introduction

The right Rolling Stock for the particular needs of every Railroad Operator

Case of Tilting Trains technology

Maintenance performance as project driver from premises

• Design-for-Serviceability: how experts keep Maintenance performances under control
• Modern means for continuous improvement of the maintenance all asset life-long
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Factoring Train Design into a comprehensive Maintenance System

Maintenance Engineering in New Build and Maintenance projects

- Commitment on targets of **Operational Performances**
- **Maintenance Concept & Strategy**, applicable regulations
- **Fleet sizing**
- **Workshops sizing**
- **Maintenance Cost Model**
- Definition of any **Service Support** required for reaching the ambitions
  (tailored offer including deployment of new processes & tools)
- **Alstom Units & External Suppliers** under control, especially **Material & Off-Train activities**
Availability as a dynamic target:

- Downtime costs « zero » when vehicles are not needed for revenue service!
- Good maintenance strategy often leads to fleet size optimization (impact on acquisition cost)

DAY VIEW (Passengers Main Line)
Downtime allocation for the different types of maintenance

WEEK VIEW (Passengers Main Line)
Typical needs for revenue service (% trainsets available)
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Key drivers for having Railways business under control

Maintenance LCC (Life Cycle Cost):

Technical cost:
- Labour + Material
- Systematic Preventive → CBM → Corrective // Cleaning
- Make vs Buy (on-train, off-train)

Total cost:
- Operational procedures: handover, pre-service check...
- Productivity, workload variation
- Logistics (shunting, parts handling...)
- Support functions
- Training...
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Maintenance Engineering in New Build and Maintenance projects

**DESIGN–FOR–SERVICEABILITY (DFS)**
- Maintenance performances: Cost, Downtime
- Means of reaching targets: Reliability, Accessibility, Testability, Cleanability, Depot facilities...
- Challenge & Rationalize all kind of maintenance including Safety-related tasks
- Obsolescence under control

**DELIVERABLES OF INTEGRATED LOGISTIC SUPPORT (ILS)**
- Logistic breakdown: LRU & SRU as input for DFS + ILS database as repository
- Maintenance Plan, Maintenance Tasks Analysis (MTAs), Maintenance & Operations Manuals, (lists of) Spares, Special Tools (including Test Equipment), Training material...
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Maintenance Engineering in New Build and Maintenance projects

Tender  Design  Mobilization  Warranty  Maintenance

WHEN DESIGN–FOR–SERVICEABILITY SAVES A RAIL TRANSPORTATION BUSINESS

On AGV it is possible to remove the Traction Motor without removing the bogie or the wheelset.

This saved the business of the first private operator of passengers main lines transit in Italy, NTV, when at start of service the life-time of the original silent blocks was about 1.5 month... vs 3 years expected.
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Maintenance Engineering in New Build and Maintenance projects

Tender ➔ Design ➔ Mobilization ➔ Warranty ➔ Maintenance

MAINTAINABILITY DEMONSTRATIONS
• If they could not be completed on 3D model or in manufacturing facility

DELIVERY of « Final Documentation », Spares & Tools

TRAINING SESSIONS to Drivers and Maintainers

DEPLOYMENT OF MAINTENANCE :
COMPREHENSIVE SET OF PROCESSES & TOOLS... and PEOPLE !
• Management of Operational Performance : Reliability, Availability, Cost
• Maintenance Planning, Fleet Management
• Industrialization of Maintenance, Optimization of Execution
Maintenance Engineering in New Build and Maintenance projects

Tender → Design → Mobilization → Warranty → Maintenance

TRAINING : E-LEARNING

Efficient E-Learning

Connected Workforce

RELIABILITY MONITORING

Delay > 10'

Failure Per Million Km

FPMK 4 Sliding months → Target Delay > 10'
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SERVICES EXECUTION SYSTEM (SES)

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Factoring Train Design into a comprehensive Maintenance System

Maintenance Engineering in New Build and Maintenance projects

- Tender
- Design
- Mobilization
- Warranty
- Maintenance

HEALTH HUB™

Ergonomic and scalable interface, adapted for any fleet size

Unique train health radar for immediate assessment

Direct link to integrated systems (e.g., TrainScanner™)

Direct link to open a Work Order in the MMS (pre-captured)!

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DYNAMIC MAINTENANCE PLANNING, DIGITAL PLANNING BOARD

Electronic – Planning Board

TASKS SEQUENCER, DEMANDS OPTIMIZER