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TRAINING PATHWAYS ECO-INNOVATION: TRAINING CURRICULUM ENERGY EFFICIENCY

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1 INTRODUCTION

In the study "Analysis on Energy efficiency deployment – BUDAPEST" we have presented in detail the three factors having the greatest impact on energy consumption of rail freight transport: vehicle (vehicle dynamics), human factor (driving process), as well as the preparation of timetables in favour of energy-efficiency.

Out of the three mentioned factors in the study "Development of Loco drivers' training program to achieve energy efficient driving style – Budapest" we focused on the human factor and presented the regulation of loco driver's training and examination in the EU and in Hungary, respectively the current situation of training-examination in Hungary. In the study we made proposals how to include the energy-efficient driving (eco-driving) to the training process and how to draw the attention of loco drivers to the importance of energy-efficient driving. This driving method should to become later instinctive or rather routine during the drivers' work.

This present document brings us one step closer to the implementation of eco-driving: it gives a short methodological outline to the structure and application of the trainings.

Lokomotion will give some additions to this basis under special view of driving threw 3 countries Germany, Austria and Italy with multisystem locos over physically challenging steep and narrow winding alpine mountain tracks with up to 2 locomotives in multi traction. Those operate under different conditions of with energy recuperation (in Austria and Germany only) and an energy policy in Italy, with no benefits for energy saving driving.

Another focus is the fact of working together – as not native German speaker with different kind and culture of traffic controllers - moreover on different types of locos – including older (upgraded) models.

Under these conditions the educations aspects of locomotive drivers training a various and need to be constantly trained and monitored.

2 TRAINING CURRICULUM

2.1 Theoretical foundation

Part I. Presenting the ideal traction

- significance of traction energy as most important cost factor for railway undertakings
- driving style: intensive acceleration – rolling out – braking
- no influencing factors
- display of the energy used (later the development of the energy with influencing factors)
- basic influencing factors during traction → tractive mechanics: mechanical work, performance, kinetic energy, basis of tractive mechanics, tractive resistance (basic resistance: rolling resistance, pin-chafing resistance, rail-rolling resistance aerodynamic resistance, special components of basic resistance; additional resistance: track resistance /elevation-and curve resistance/, acceleration resistance, wind resistance, starting resistance)
- best score of energy efficiency is a case of team work with the infrastructure colleagues (traffic controllers) in charge
- use of recuperation brakes saves money for the company
- electrical shut down of locomotive during storage periods
- reduced energy consumption also seen under the positive view of climate conservation
- driving with up to 3 locomotives min multi traction

Part II. Which factors may influence energy consumption during train forwarding?

1. Geographical conditions of the track (elevations, slopes, curves)
    - Advantages and disadvantages of tracks in mountainous areas:
      → Conditions that could be exploited
      → Factors increasing energy consumption (is there something to do about them?)
    - Differences of traction on flat and mountainous tracks
      → Elevations require more energy to accelerate, but on a slope this might be exploited,
      → Curve in an elevation increases energy requirements significantly
      → In elevation train slows down, useful for stopping
      → The role of route knowledge is more important on mountainous tracks
    - Effect of track curves on traction
    - Recuperation on Austria and German network - using electric brake to recuperate esp. on downhill drive
    - Motivation for intercultural teamwork on the NAPA route with up to 3 traffic controllers

The geographical layout of the tracks has a significant effect on the amount of energy used.
Exploitation of elevation: I will stop the traction earlier, because I would need to brake anyway – the track slows down. Exploitation of slope: I need less tractive power at start or at traction on a slope. Recuperation braking.

2. Weather conditions
   - Environmental effects:
     → Precipitation,
     → Contaminated rail (leaves, snow, oil, etc.),
     → Wind
   - Applicability of ideal acceleration (avoiding wheel-spin, for that harms the running surface of the wheels; spin and sudden adherence between wet and dry sections are harmful as well),
   - Speed-keeping.

   From the perspective of the use of energy the weather is an important factor mainly at start-up and acceleration, but has an effect on braking as well (increased braking distance, ineffective use of recuperation braking). It has adverse effect on the many accelerations and decelerations in bad traffic situations and on bad tracks: more energy is required.

3. Quality of the rail track (speed-limit signals)
   - Effect of poor-quality track on the train speed → temporary and permanent speed-limit signals
   - Energy-saving possibilities:
     → Choose slow, but almost constant speed
     → After start-up I shall not accelerate to maximum speed for I know there is a speed-limit signal coming (the role of route-knowledge!)
   - Malfunctions of interlocking: undue triggering
   - ETCS problems: could be improved, because the system knows the permanent slow-runs.

4. Parameters of the train to be forwarded (tonnage, air loss)
   - Determination of tonnage: the goal is high utilisation, if transporting
     → What is that determines the maximum load?
     → What limits can be considered?
   - Is the forwarding of one heavy train more effective than of two lighter trains?
     → track capacity
     → network access charges
     → locomotive performance
     → demand: is there anything to transport and is that many necessary?
     → distribution of capacity

→ performance of air compressor

- Trains with air loss: consumption of air compressor is significant too
- Condition of wagons: „releases slowly", significance of maintenance
- Effects of the amendment of Braking Instructions E.2. on the forwarding of freight trains (which are these specific points?)

5. Determination of ideal speed to be applied during train forwarding
   - What does determine the maximum applicable speed of a train (locomotive, load paths, tonnage)?
   - Is the application of maximum speed by all means necessary?
   - Ideal speed determined by the loco driver
     → there is a passenger train ahead of us, it does not make sense to accelerate and brake all the time; it is more effective to choose lower speed
     Advantages:
     → almost constant speed can be applied

6. Traffic regulation (late signal handling, switches, waiting)
   - Proactive talk with traffic controller(s) to get a picture of the surrounding traffic situation
   - Late signal handling → it depends on the traffic controller who is not handling signals in time for the train's moving forward, causing unnecessary hold-ups.
   - The train is moving on a passing track because of a crossing or another train which was given priority:
     → with reason,
     → without reason, because our train "would have still fitted in", but was not allowed.
   - A passenger train calling at each station or a slower freight train is going ahead of us.

We cannot keep a constant speed with our train because there are many decelerations and accelerations or repeated starts due to the above mentioned. These require a surplus of energy consumption.

<u>Furthermore it has to be mentioned:</u>

- How big the ratio of the above factors is in energy consumption
- The role of recuperation
- Detectable, individual measurements (comparison of similar trains, importance of the role of driving style; the same train with less, respectively more stops)

2.2 Practice

The practical part of the training takes place by using locomotive simulator.

- Outline of the situation by the locomotive simulator (train parameters, from where-to where, weather conditions, etc.)

- Introduction of track characteristics (longitudinal profile scheme, track curves, slow-runs, station plans, position of signals)

- Introduction of the loco simulator's consumption-meter (it is not certified, but suitable for training: it is possible to conclude the consumption rate; it shows the ratio of consumed and recuperated energy very well).

- Giving instructions:
    1. Everyone shall drive three times.
    2. During the first drive everyone shall examine the track, regardless of consumption.
    3. During the second drive everyone shall drive as he/she thinks it is the most efficient.
    4. During the third drive he/she shall follow an enclosed instruction and shall monitor the development of consumption compared with the first and second drive.
    5. The amount of the consumed and recuperated energy shall be recorded during all three drives. The results are going to be evaluated at the end of the drive.

- Periodical repetition of training in locomotive simulators and group competitions events
- Coached trains drivers from time to time to refresh the knowledge and attention to get a routine
- Regular meetings of traffic controllers and drivers "on the job" to promote cooperation and understanding
- Permanent training of communication in German (as native Italian speaking driver)

2.3 Feedback

At the end of the eco-driving training we recommend asking the participants in writing about the acceptance and comprehension of the training's goals, about the effectiveness of the applied methods and their remarks and suggestions concerning the training.

The survey should be short, clear, and easy to comprehend and to answer. The results of the survey can be used for the further development of the training.

Periodically feedback on live data's of the drivers train runs in regular retraining courses

A reporting system to management enables the driver, if there are mismatches with participated traffic controllers of infrastructure companies.