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STREP

PRIORITY FP6-2005-Transport-4 “Sustainable development, global change and ecosystems”

2TRAIN

TRAINing of TRAIN Drivers in safety relevant issues with validated and integrated computer-based technology

Publishable Final Activity Report

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Duration: 39 months

Project coordinator name: Prof. Dr. Hans-Peter Krueger

Project coordinator organisation: Bayerische Julius-Maximilians-Universitaet Wuerzburg

1 PROJECT EXECUTION

Background and impact

The establishment of safe, competitive and interoperable railways in Europe demands a particular attention to the qualification of train drivers. In order to strengthen a European harmonisation in rail traffic it is appropriate to advance common training technology as well as common training contents. Developments concerning these two aspects are the scientific and technological objectives of 2TRAIN.

Individual European countries differ in national laws, engine technology, signalling systems, rule books, and general training structures (e.g. extent of simulator use). Hence, a complete harmonisation of training technology and training contents will be unachievable. Nevertheless, as Europe grows together and cross-border operations increase there is a strong need to harmonise and coordinate the education of train drivers concerning general driving and operational abilities as well as particular crisis management competencies.

The use of computer-based technologies (simulation and CBT) is a prerequisite for the establishment of common training efforts for train drivers in Europe. It enables an interactive training of realistic situations. In contrast to training in the real environment the training session can variably be composed of different technical failures and irregular operational situations of which many cannot be trained in reality. Furthermore, it is possible to replicate scenarios at any given time.

A lot of work has been done in the past to harmonise and standardise education and advanced training for train drivers (e.g. European driver licence). But nevertheless there is a further need to train safety relevant human factors in order to deal with hazardous situations and to reach a consistent level of these competencies across Europe. Research shows that approximately 80-90 percent of all railway accidents can be attributed to human factors. Hence, the training of important human factor competencies remains a main issue for future research.

Objectives

2TRAIN aims at two main objectives:

- The first objective is to reach a maximum utilisation of the latest computer-based training technology and to develop a modular platform in order to enable an integration of these technological solutions in existing training environments throughout Europe.

- The second objective is to increase the train drivers' competency in crisis management by defining and realising appropriate human factor training scenarios that will be evaluated and validated within the demonstration phase.

At the end of the project, 2TRAIN delivers a European best-practice guideline for an efficient, safety enhancing and cost-effective use of modern technologies for the training of train drivers as well as for the ongoing competence and performance assessment.

In order to reach the objectives 2TRAIN conducts the following work packages:

- Benchmarking training technologies, and training and assessment curricula in today's Europe
- Specification requirements for future training
- Development of training contents (human factors training for dealing with rarely occurring and especially hazardous situations)
- Development of training and assessment methods (computer based tools including simulation, enabling technologies) that are based on a common data interface
- Evaluation of the developed methods in pilot studies (training effects, acceptance)

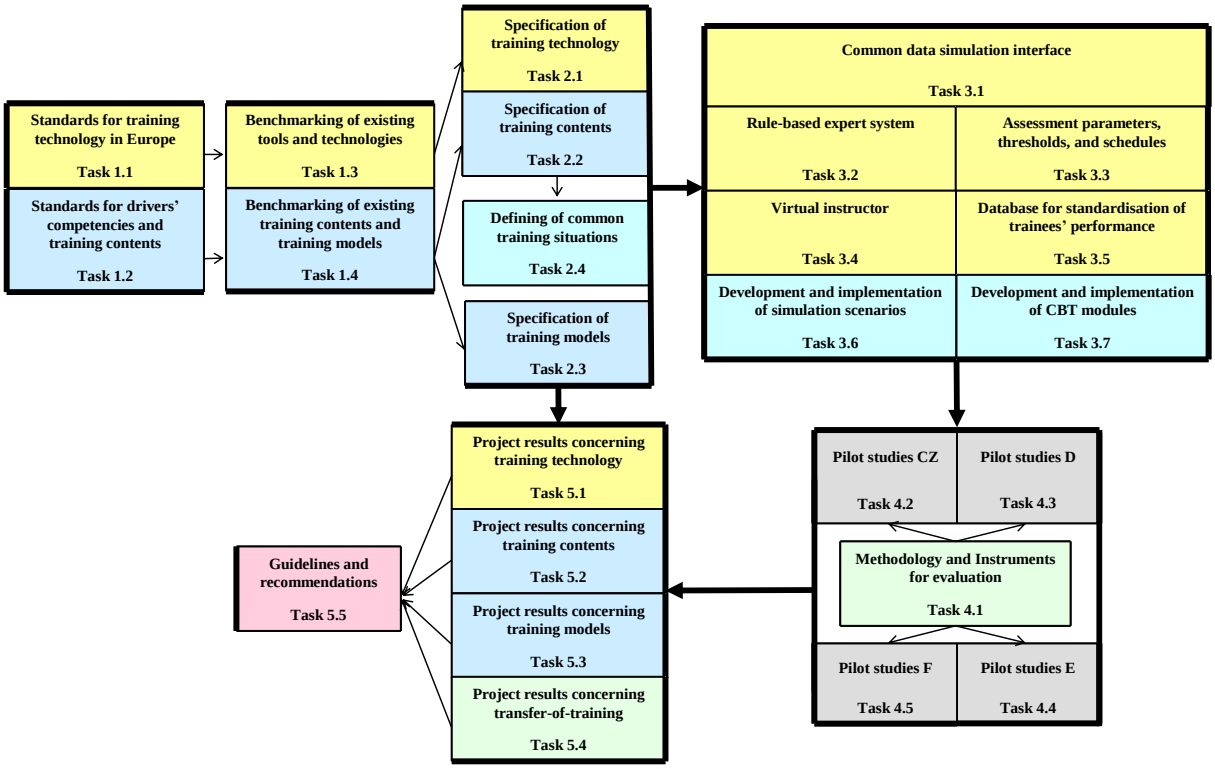

Figure 1: Graphical presentation of 2TRAIN work packages

Performed work and achieved results

In the following, an overview of the project execution is given.

- Starting point of 2TRAIN was the benchmarking of training tools and technologies as well as training contents and models already in use in different European countries. The main purpose of this benchmarking process was the collection of data about training systems of European railway undertakings with a special focus on simulation and training contents related to driving under abnormal/irregular conditions as well as human factor contents. As a first step, a short questionnaire was developed and sent to railway undertakings in Europe. After the analysis of the results of this first questionnaire a sample of 18 railway companies representing 80.000 train drivers was selected for a more detailed face-to-face interview and the accordant key questions forms were developed. The project partners interviewed representatives of the selected companies.

Figure 2: Benchmarking sample

At the end of the benchmarking two detailed reports were prepared as project deliverables, one covers training tools and technology, the other training contents and training models. Additionally, a combined report that covers the most interesting results and has a modern layout was prepared (Schmitz, M. & Maag, C. (Eds.) (2008). Benchmarking report on computer-based railway training in Europe. 2TRAIN project report. Available at http://www.2train.eu; 159 pages).

- The results of the benchmarking process fed the specification of the detailed project contents. Based on the answers of the railway companies and the discussions with the representatives of the companies the requirements for future computer-based train driver training were specified. Especially the reported shortcomings that hinder an optimal use of the existing training technology fed the specification. The major point of criticism stated by the interviewed companies is the missing possibility to create new exercises and scenarios without

the support of the manufacturer. The weak assessment capabilities of the simulators and in particular the quality of the simulator reports that can be printed out after a simulation run are other important drawbacks of the existing technology. The specification procedure guarantees that the further project steps were adjusted to the needs and requirements of the future users of the 2TRAIN results.

- A further task of the specification process was the application of the specified common training contents by developing common training situations that are be realised in simulator scenarios and CBT modules. After the implementation these scenarios and modules are used during the demonstration activities of the project. Taking into account existing European differences concerning rules and regulations 2TRAIN focuses particularly on training contents related to crisis management competencies.
- Due to the current individual company standards in training technology a universal simulator for all European countries is not realistic. Instead, a common data simulation interface was developed within 2TRAIN to allow a standardised data recording and to provide the opportunity to implement add-on systems.

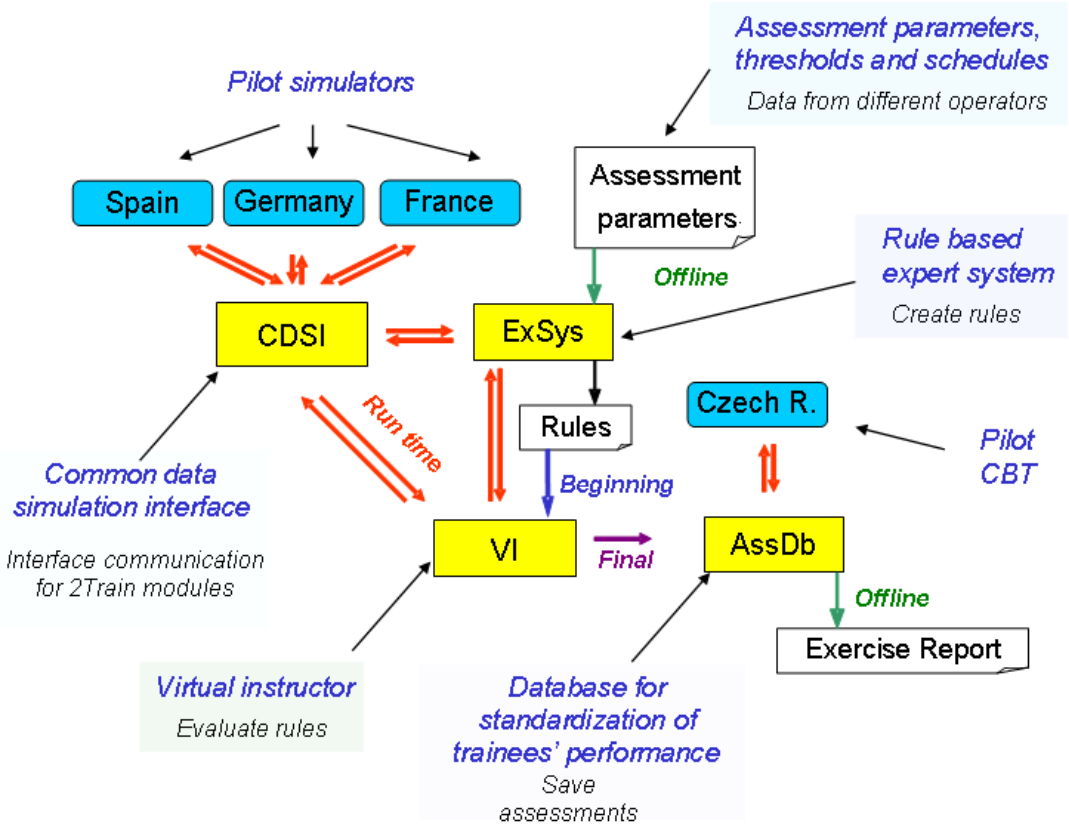

Figure 3: System of add-on tools

The common data simulation interface also ensures that the system can be expanded to new technological developments. The definition of assessment thresholds and schedules as well as the layout of the simulator report that is printed out after the CBT or simulator exercise was completed. The work on the add-on tools for simulators – rule-based expert system (ExSys), virtual in-

structor (VI), and assessment database (AssDB) – is almost completed. The ExSys defines and stores the target behaviour (i.e. correct behaviour) of the train driver for different scenarios. The VI is responsible for running the assessment procedure online. Therefore, the VI receives the data about the actual behaviour of the train driver during the simulator exercise from the CDSI and compares it with the target behaviour and assessment rules from the ExSys. The resulting assessment data (e.g. driving deviations, errors, reaction times) are stored in the AssDB. The assessment data that are stored in the AssDB in a standardised form serve as a basis for generating an assessment report at the end of the training session. Minor adjustments and modifications of the developed tools will be done if problems or functional requirements emerge during the forthcoming demonstration activities.

- After the technical development of the different add-on tools the main objective of the subsequent demonstration activities lied in the functionality and acceptance testing of the software tools. At four different demonstration sites the technological developments of 2TRAIN were presented: Czech Republic (CBT study), Germany (simulation and CBT study), Spain (simulation study), France (simulation study). In order to guarantee comparable results of the demonstration activities at the different European pilot sites, a common methodology and common instruments were used. Mainly train drivers and instructors/trainers participated in the pilot studies as this group will be primarily affected if the 2TRAIN simulator technologies are introduced in the regular training and assessment procedures. The evaluation took place under realistic conditions and included a significant number of participants in every pilot site. The evaluation was focused on the usability, practicability, and acceptance of the developed training technology and training contents.

Pilot site	Sample size	Simulator type	CBT/WBT	2TRAIN simulator exercise	VI working mode
Czech Republic	38	None	4 modules	none	none
Germany	44	Full cab with motion	2 modules	ICE simulator	assessment, help, guidance
France	21	Partial cab without motion	none	TGV simulator	none
Spain	15	Mini simulator and partial cab	none	Light rail simulator	assessment, help, guidance

Table 1: Description of demonstration studies

- The demonstrations and the feedback by train drivers, instructors, and training managers proved that the 2TRAIN system for assessment and training of train drivers can be implemented on existing simulators throughout Europe. The 2TRAIN tools can be considered as a modular package able to interact with very different systems. Beyond the purely technical success, the feedback from intended end-users is extremely positive. All in all, the results were very positive and showed that the developed technology is accepted by train drivers and instructors/trainers and has the potential to enhance the quality of training and assessment. The simulator report has been appreciated very

much and the participants at the evaluation studies expect a significant enhancement of learning efficiency due to the 2TRAIN system.

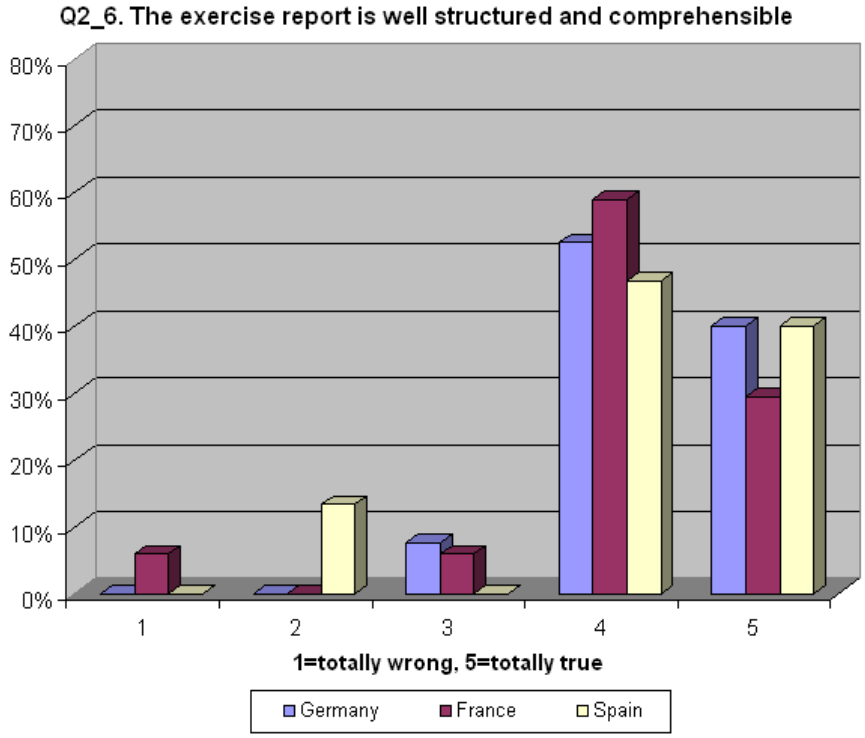

Figure 4: Evaluation of exercise report

- The public reports that were prepared during the 2TRAIN project (1) identify which technology for the training and assessment of train drivers is appropriate in terms of acceptance, usefulness and cost-effectiveness, (2) analyse which competencies can be trained effectively by which training contents, (3) examine the influence of the training setting and the training and assessment schedule on the cost-effectiveness of the training, and (4) measure the impact of the training for the daily duty of the train drivers in their workplace.
  A final report and a report on guidelines and recommendations integrate all project results and give further recommendations for end-users respectively operational railway companies. These reports provide the interested railway stakeholders with information for adapting training technologies, contents and models and to benefit from the 2TRAIN results.

Linked with the benchmarking and specification process was the establishment of a user group. The user group consists of further railway companies – besides the 2TRAIN partners – of different countries that are interested in participating in the project.

Figure 5: Members of 2TRAIN User Group

Bringing in their expertise in the benchmarking process (information about existing procedures and research) the input of the user group helped to broaden the project results. Over the course of the project the user group met in two workshops to exchange information about existing training tools as well as training and assessment procedures. The first meeting was held in June 2007 in Madrid, Spain. During this meeting the user group was informed about the benchmarking process and discussed the results. The second meeting took place in June 2009 in Hamburg, Germany. This meeting demonstrated the 2TRAIN assessment and training systems as well as the technical tools to the participants. By setting up a user forum, it was ensured to include the users' needs in the whole process and to reach a wide dissemination of the 2TRAIN results. Furthermore, the design and installation of the 2TRAIN website (www.2train.eu) supports the wide dissemination of 2TRAIN. Interested companies could register in order to get access to all news and additional information.

Coordinator

The 2TRAIN project started on October 1, 2006, has a duration of 39 months, and is coordinated by the

University of Wuerzburg
Centre for Traffic Sciences (IZVW)
Roentgenring 11
97070 Wuerzburg (Germany)
http://www.izvw.de

Involved contractors

The 2TRAIN consortium consists of 11 partners from 5 EU member States. It includes railway operators, simulator manufacturers, and research institutes. The project participants are:

- Corys T.E.S.S. (France)
- Ceské Dráhy (Czech Republic)
- Ceské Dráhy Cargo (Czech Republic)
- Krauss-Maffei Wegmann, Division Training & Simulation (Germany)
- Deutsche Bahn AG, DB Training (Germany)
- SNCF (France)
- Jan Perner Transport Institute (Czech Republic)
- Rail Training International (United Kingdom)
- Universität Passau, Chair of Computer Networks and Computer Communications (Germany)
- Universidad Politécnica de Madrid, Centro de Investigación en Tecnologías Ferroviarias (Spain)

Project website

Further information about the project's goals and results along with announcements of major 2TRAIN-related events (and a registration form in order to become a member of the 2TRAIN user group) are available at the project's website: http://www.2train.eu

2 DISSEMINATION AND USE

Publishable results

Common Data Simulator Interface (CDSI)

- Description: CDSI provides a standardized interface to disparate simulators from various manufacturers. Therefore, the CDSI allows a standardised data recording and provides the opportunity to implement simulator add-on systems from manufacturers different from the simulator manufacturing company. This is innovative, because up to now add-on tools cannot communicate with simulators due to missing standards of data interchange. All kind of simulation data can be accessed from outside the simulation system by means of CDSI. Within the 2TRAIN project the CDSI data is used for detailed assessment with the 2TRAIN add-on modules.
- Market application: Training of drivers (train drivers, car drivers, bus drivers) by using simulators and other computer-based technology (CBT, WBT)
- Stage of development: Prototype and demonstrator available, ready for market
- Collaboration: Training provider who is interested in using the technology for enhancing the training capabilities and efficiency of his training environment
- Intellectual property rights: Developed Source code is ownership of Corys T.E.S.S.
- Contact: Jacques Moncorgé, Corys T.E.S.S., 74 avenue des Martyrs, 38027 Grenoble Cedex 01, France jmoncorge@corys.fr

Rule-based Expert System (ExSys)

- Description: ExSys defines and stores the target be-haviour (i.e. correct behaviour) of the train driver for different scenarios. In or-der to realise a detailed assessment of the train driver's performance during a simulator exercise, the simulator data are compared with the data from the ExSys. KMW was responsible for the development and programming of the ExSys. ExSys contains a sophisticated Graphical User Interface, which al-lows displaying any CDSI data out of the simulator. This is done online, during the simulation run, in different configurable formats, even with data not displayed in the original Graphical User Interface of an existing simulation system.
- Market application: Training of drivers (train drivers, car drivers, bus drivers) by using simulators and other computer-based technology (CBT, WBT)
- Stage of development: Prototype and demonstrator available, ready for market
- Collaboration: Training provider who is interested in using the technology for enhancing the training capabilities and efficiency of his training environment
- Intellectual property rights: Developed Source code is ownership of Krauss-Maffei Wegmann GmbH & Co KG

- Contact: Oliver Bungers, Krauss-Maffei Wegmann GmbH & Co KG, Krauss-Maffei-Str. 11, 80997 München, Germany, oliver.bungers@kmweg.de

Virtual instructor (VI)

- VI is an application responsible for the real time assessment based on the target behaviour described on the rules. It monitors the execution of the simulation exercise and performs the assessment tasks. The VI receives the data about the actual behaviour of the train driver during the simulator exercise from the simulator and compares it with the target behaviour and assessment rules. The VI also provides online information to the train driver on how to improve his performance. UPM was responsible for the development and programming of the VI.
- Market application: Training of drivers (train drivers, car drivers, bus drivers) by using simulators and other computer-based technology (CBT, WBT)
- Stage of development: Prototype and demonstrator available, ready for market
- Collaboration: Training provider who is interested in using the technology for enhancing the training capabilities and efficiency of his training environment
- Intellectual property rights: Developed Source code is ownership of Centro de Investigación en Tecnologías Ferroviarias
- Contact: José Manuel Mera, Centro de Investigación en Tecnologías Ferroviarias (CITEF), José Gutiérrez Abascal, 2, 28006 Madrid, Spain, citef.jmmera@etsii.upm.es

Assessment Database (AssDB)

- Description: AssDB stores the assessment data of every trainee. The AssDB serves as a basis for generating an assessment report at the end of the training session. Further input to the AssDB is information that derives from other training methods (e.g. CBT/WBT). By this, the AssDB is expanded to be a competence management system. UP was responsible for the development and programming of the AssDB. With the help of the data-base, long term learning data recording is possible and allows an access to the performance and competence indicators of an individual trainee at any time.
- Market application: Training of drivers (train drivers, car drivers, bus drivers) by using simulators and other computer-based technology (CBT, WBT)
- Stage of development: Prototype and demonstrator available, ready for market
- Collaboration: Training provider who is interested in using the technology for enhancing the training capabilities and efficiency of his training environment
- Intellectual property rights: Developed Source code is ownership of University of Passau
- Contact: Hermann De Meer, University of Passau, Faculty of Informatics and Mathematics, Innstrasse 33, 94032 Passau, Germany, demeer@fmi.uni-passau.de

Assessment concept

- Description: For useful and accurate assessment results, a thorough planning (storybook) specific to each used simulation scenario is mandatory. This involves defining target behaviour, assessment parameters and thresholds and monitored data (assessment based on performance markers). This task is simplified by using predefined rule templates, which define these issues for specific training situations (e.g. passing a level crossing or react to autonomous application of the brakes.) Rule templates are simply placed along the track of a scenario and parameterized to configure assessment for this scenario.
- Market application: Training of drivers (train drivers, car drivers, bus drivers) by using simulators and other computer-based technology (CBT, WBT)
- Stage of development: Prototype and demonstrator available, ready for market
- Collaboration: Training provider who is interested in using the assessment concept based on performance markers for enhancing the training capabilities and efficiency of his training environment
- Intellectual property rights: University of Wuerzburg
- Contact: Marcus Schmitzi, University of Wuerzburg, Centre for Traffic Sciences (IZVW), Roentgenring 11, 97070 Wuerzburg, Germany, schmitz@psychologie.uni-wuerzburg.de