Policy-Oriented Measures for Tuning and Intensifying Rail Higher Education on both Sides of the Atlantic

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Abstract
This paper provides an overview of the Tuning Transatlantic Cooperation in Rail Higher Education (TUNRail) project, describes the methodology employed for data collection and analysis, and reports on the interim results obtained. Forthcoming activities and further research are also discussed. The paper invites rail professors and assistants, fellow researches, policy and decision makers, and industry stakeholders to liaise with the TUNRail team and assist in better understanding of the current supply and demand pattern of rail higher education on both sides of the Atlantic.

Keywords
Rail Higher Education, Rail Industry, Surveys, Transatlantic Collaboration, Knowledge Exchange

1 Introduction

The world is changing fast and rail transportation is no exception. More skills are needed from rail industry professionals than ever before which necessitates higher level and continuously developing skills and qualifications. Learning is a natural skill for human beings, but adequate sources to learn from need to be available.

Future rail professionals who serve in the diverse rail industry must be able to master increasing levels of new information technologies and system complexities which differ

from the historical concepts that concentrated more on local issues. Such a critical need must be addressed in the rail higher education and also suggests that university programs offered in the field should be more globally oriented and employ interdisciplinary approaches.

The transition to a more global rail education and training can be facilitated by initiating a closer collaboration between higher education institutions and industry stakeholders on both sides of the Atlantic.

TUNRail is a policy oriented measures project funded in collaboration between European Union (EU) and United States (US) Department of Education and intended to "tune" and intensify the railway higher education knowledge exchange and collaboration between the EU and the US. More specifically, this project uses benchmarking and comparisons analyses to investigate the current rail education programmes, and on identifying how well they address the key aspects of modern railway systems. The TUNRail project increases transparency, identifies similarities and differences between railway systems and educational programmes, and provides a solid foundation for more extensive cooperation and for the establishment of new programmes on both sides of the Atlantic. The work also compares and evaluates and current teaching and learning practices of the railway systems in European and US institutions of higher education, and defines the level of collaboration between the academic programmes and the railway industry.

The consortium partners believe that TUNRail is the first time when a multilateral US-EU policy oriented measures project is proposed to "tune" current educational programs and to intensify transatlantic cooperation in railway higher education. TUNRail builds on several years of discussions between the consortium partners to initiate increased collaboration and can be considered as an innovation in itself. It is also believed to be a timely and important project due to increasing interest for modern "non-traditional" rail transportation and growing trend that demands a more "global" approach from the stakeholders participating in the development.

Another innovative element is the extensive use of internet and live web conferences as a means allowing feasible communication and interaction among the project partners (research team and evaluators), as the main tool to secure stakeholder input and participation in the process, and in disseminating the project outcomes to the stakeholders. While international forums and web conferences have been actively utilized in other fields, the research team doesn't know of previous occurrences, where results of a railway education research are disseminated via web. It is expected that the outcomes of this project will encourage for increasing transatlantic collaboration via technology by the railway education and industry sector.

This paper provides an overview of the Tuning Transatlantic Cooperation in Rail Higher Education (TUNRail) project, describes the methodology employed for data collection and analysis, and reports on the interim results obtained. Forthcoming activities and further research are also discussed. The paper invites rail professors and assistants, fellow researches, policy and decision makers, and industry stakeholders to liaise with the TUNRail team through its webpage: www.tunrail.info and assist in better understanding the current supply and demand pattern of rail higher education on both sides of the Atlantic.

The paper is organized as follows: Section 2 provides an overview of the TUNRail project. Section 3 discusses the methodology employed for data collection and analysis. Section 4 reports on interim results obtained, followed by conclusions, forthcoming activities and further research presented in Section 5.

2 The TUNRail Project: An overview

2.1 Motivation

The team has been motivated by the fact that the extent and the level of maturity of rail higher education in the EU and US are different. In addition, the rail industries have significant differences. For example, the intercity rail transportation in the US concentrates on freight while in the EU it is heavily passenger oriented which may lead to differences in the industry demands. The motivation for embracing this initiative was to understand the differences and similarities of the rail higher education (supply), and in the structure and requirements by the rail industry (demand), to the extent possible, in order to be able to improve the current practice by identifying specific recommendations and strategies for enhanced transatlantic knowledge transfer and for development of new programmes in the future.

The outcomes of collaborative effort and analysis are envisaged to function as a foundation for expanded Transatlantic collaboration in the field.

2.2 Objectives

The main objective of the TUNRail project is to provide an expanded understanding of how to improve the quality of the railway higher education on both sides of the Atlantic and further contribute to the development and modernisation of the entire railway sector through up-to-date educational practices. More specifically, the main activities and objectives include:

- Identification of synergies and key differences between the railway systems and industry in the EU and US and their effect on demand, type and objectives of railway higher education;
- Inventory and comparison of the status of railway higher education in the EU and US;
- Comparison of current levels of industry participation in the programs and development of promising approaches for closer collaboration;
- Utilization of the obtained results to multiply railway higher education by convincing stakeholders to consider TUNRail outcomes as part of the evaluation of existing programmes and/or the development of future programmes.

2.3 Consortium

TUNRail consortium consists of five Universities and two external evaluators. The consortium includes:

- Two Lead Universities, Michigan Technological University in the US and Instituto Superior Tecnico in EU;
- Two Partner Universities, University of Illinois at Urbana-Champaign in the US and Braunschweig Technical University in EU. In addition, the University of Newcastle upon Tyne is participating in the research team;
- Two External Evaluators, Mr Thomas White of Transit Safety Management, Inc. in the US and Prof John Preston from University of Southampton in EU;

2.4 Management Structure

TUNRail management structure includes two main streams, as follows:

- Vertical Stream;
- Horizontal Stream.

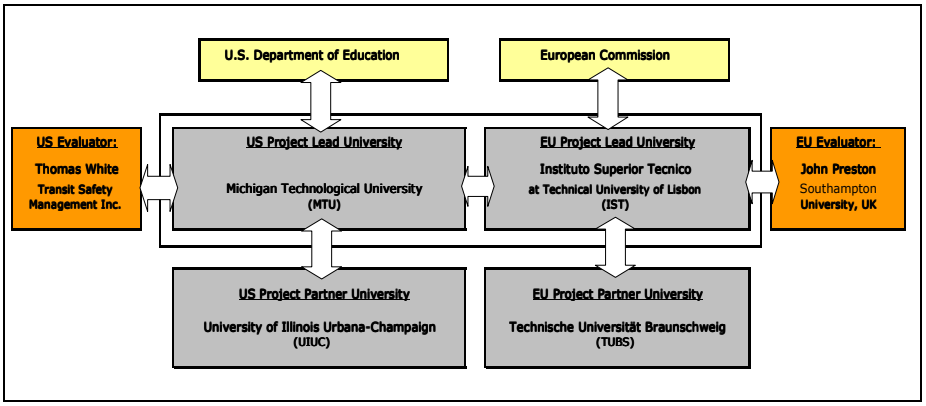

Illustration 1: Project Management Structure

The **vertical stream** secures feasible coordination of the project. It involves the internal coordination between the team members and the communication flow between the European Commission, the US Department of Education and the Lead Universities.

The **horizontal stream** ensures the consistency of work throughout the project lifetime and the quality of the project outcomes, deliverables and final products. It involves mainly the lead universities and the evaluators, but may also involve the specific task leaders.

The TUNRail management structure and the relations between the vertical and horizontal streams are illustrated in Illustration 1.

2.5 Work Plan

The proposed duration of TUNRail is 24 months. Consecutive and parallel tasks are conducted to achieve the project objectives. Each task has a task leader but whole team coordinates tasks in monthly web conferences and works in a collaborative manner to produce the outcomes of all the tasks.

The Work Plan of the TUNRail project consists of specific components and activities as presented in Table 1.

Table 1: TUNRail Work Plan

Components of the project	***Outcomes to be achieved / produced through the component***	***Activities leading to this outcome***	***Dates for activity to be started and completed***
Task 1. Data Collection	D1. Comprehensive data set of the current railway higher education programs and on the perceived needs by the industry.	• A Survey on the current university study programmes and courses • Online industry survey • Development of (E-forum)	• Launching the Project • 2009 FIPSE/DG EAC conference -Atlantis Annual Meeting – 1st year
Task 2. A Comparative / Evaluation Study	D2. Analysis and Evaluation of Rail High Education Programmes and Practices	• Evaluation of the current programs through synthesis and comparative analysis	• Coordination with Task 1 • Selection of appropriate comparative/evaluation methods • Implementation of selected method • Identification of the synergies
Task 3. Identification of Innovative and Successful Educational Practices	D3. Case study report on the innovative and successful practices in railway higher education	• All the activities in Task 1 and Task 2 • In-depth analysis of available material and by interviews	• Selection of the most innovative and successful practices • Classification of university railway programs • Description of characteristic laboratories and models

Task 4. Recommendations / Strategies for Enhanced Knowledge Transfer and for Program Development / Improvements	D4. Recommendations and Strategies for Enhancing Rail Higher Education Outcomes	• Review and evaluation of materials developed in the Tasks 1 through 3	• 2010 FIPSE/DG EAC conference -Atlantis Annual Meeting – 2nd year • Specifying recommendations for: 1) enhanced transatlantic knowledge transfer, 2) development of new programs and 3) improvement to current programs.
Task 5. Dissemination of Research Outcomes and Collected Data	D5. A Handbook for Rail Higher Education and Training, web-conference and semi-annual newsletters.	• Establish the project web site and identification and involvement of stakeholders • E-Forum developed in Task 1 • All the products and outcomes from the previous tasks	• Continuously monitor and maintain both the project Web side and E-Forum • Produce and disseminate semi-annual electronic newsletters • Transatlantic web conferences

2.6 Expected Final Results and Outcomes

Main results and outcomes of TUNRail are, as follows:

- A railway education handbook that outlines:
- Comprehensive inventory and analysis (comparison and benchmarking) of current railway higher education programs and teaching practices in the EU and the US;
- Examples of better practices and successful approaches in railway higher education;
- Specific recommendations and strategies for enhanced transatlantic knowledge transfer and for development of new programs or improvement of current programmes;
- Dissemination of the obtained results to the interested parties in academia and industry;
- Better understanding of the synergies and differences of railway systems in the EU and US and a solid foundation for increased transatlantic cooperation in rail higher education and training.

Dissemination of study results is accomplished through several methods, such as:

- The Web-Page of the Project, where project postings/newsletters and e-notices of all the draft materials are made available for review and comments by interested individuals and parties;
- Open Access Web-Based Railway Education Forum / Blog to encourage continuing dialogue on the needs and imminent issues for rail higher education throughout the project life-time and beyond;
- Trans-Atlantic Web Conference for industry and academia stakeholders to present study outcomes in due time, to disseminate the need for railway higher education programs, and to obtain their feedback and suggestions;
- Conference papers and presentations to introduce the project to the industry and academia and to invite comments and feedback on the project activities and outcomes.

3 Rail Higher Education Logistics Chain

The railway higher education logistics chain could be considered to consist of three main actors as follows:

1) Railway Industry;
2) University;
3) Student.

The interactive process between the three actors and the communication flows in the railway higher education logistics chain could be outlined as shown in Illustration 2.

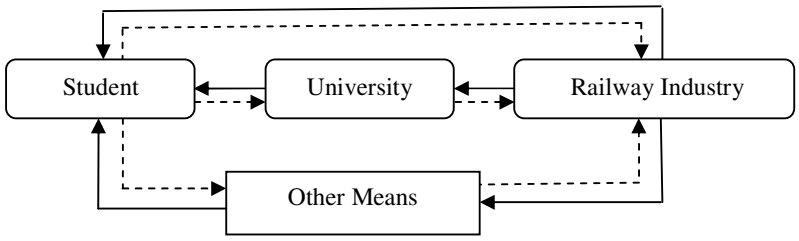

Illustration 2: A Simplified Graphical Presentation of Rail Higher Education Logistics Chain

The railway industry could be considered the main actor, as the demand for railway education would not exist without it. Thus, the railway industry also defines the level of demand for students. Following the recent trends and increasing interest in railways, it is evident that the railway industry demands are on the increase and this situation is not expected to change in the near future.

The railway industry recruits new educated candidates, either directly, through universities and/or using other means. The students, on the other hand, may recognize their interest to work for railways in similar fashion, either directly, through universities

and/or using other means.

Universities are thought of as the main stakeholder in the supply side of the chain. In ideal circumstances, universities collaborate with the Railway Industry, provide up-to-date knowledge to the students and aim to serve as an intermediate that introduces students to the industry and thus provides them with an excellent start for a career in the railway sector.

The students are interested in developing a career in the railway sector.

For the objectives of this discussion the supply-demand pattern of railway higher education on both sides of the Atlantic are investigated. More specifically, the differences and similarities of the railway higher education and of the structure and requirements of the railway industry are analyzed with the purpose of identifying specific recommendations and strategies for both enhanced transatlantic rail knowledge transfer and development of new railway programmes in the future, and hence improve the current practices of railway higher education on both sides of the Atlantic.

The methodological approach employed in this study consists of a combination of methods such as descriptive models, expert evaluations, methods for data collection, statistical analysis and case study research. The following section presents the stepwise methodology employed for data collection and analysis.

4 Methodology for Data Collection and Analysis

The purpose of developing a methodology for data collection and analysis is to gather consistent information for:

- The current trends and practices of railway higher education in EU and US universities;
- The current demands for railway higher education by the industry.

The development of the methodology was inspired by the following:

1st: The information gathered will develop a comprehensive inventory of current railway higher education programmes and activities in the US and EU and define the demands for railway higher education by the industry, both quantitatively and qualitatively. The intended outcome is a comprehensive data set of the current railway higher education programs and on the perceived needs by the railway industry summarized in a synthesis document and accompanying matrix.

2nd: The information gathered will allow the conduction of comparative analysis between the current programmes in the EU and US and analyze whether these programmes are sufficiently addressing the needs of the railway sector, both quantitatively and qualitatively. It will also investigate the synergies between the railway systems and railway higher education programs in the US and EU.

The intended outcome is a synthesis of comparative and evaluative analysis of current railway higher education programmes that includes a comparison of the key aspects of the programmes, analysis of the current programmes' capability to sufficiently fulfil the demands for railway higher education, and summary of synergies and differences between railway systems and educational programmes in the US and EU.

A stepwise methodology for data collection and analysis has been employed, as follows:

(i) There are *n* railway education programmes in *m* universities in the EU. There are *l*

railway education programmes in k universities in the US. Sub-working teams have been formed to identify railway education programmes and universities. Each team provided a list of universities that offer railway courses. In early stage of our analysis it was detected that the number of the EU universities with rail programmes exceeds significantly the number of the US universities that offer railway higher education.

(ii) The railway higher education programmes are managed by programme leaders. The sub-working teams were advised to identify railway education programme leaders and collect their contact details. After the completion of this task, a form for data collection was developed and set in Microsoft EXCEL spreadsheets. The collaborative development of the form secured that typical items from both sides of the Atlantic were covered.

(iii) Next, the form for data collection was discussed during web conference meetings held on a regular basis. After having approved the form the collection of data for current practices and study programmes for railway higher education in the US and EU (Supply Chain in the US and EU) has begun. For simplicity, we call it "University Survey". The form developed has been sent to all programme leaders indentified. The right sample size was obtained. The data collected from the university survey includes: HEI (university) name and location; structure of the railway education programme; number, name and duration of courses; number and discipline of faculty; number of staff and students involved; extent and concentration of programme materials; objectives and primary outcomes of the programme. In addition we also collected and analysed issues such as: research and teaching specialities of staff, brief history of the railway education programme and other activities pertaining to railway transport, if any.

(iv) Universities collaborate with railway industry at national and international levels. At this step, the team has made an effort to define the level of collaboration with railway industry and also the primary employers for railway education programme participants/graduates. In fulfilling this task, the team has faced the following challenges:

- Whether or not targeted industry interviews should be conducted to define the need for higher educated professionals by the railway industry in the US and EU;
- Whether or not a targeted (ad hoc) industry survey using an appropriate tool should be conducted to define the need for higher educated professionals by the railway industry in the US and EU;
- Whether or not a web based railway education forum (e-Forum) with open access should be developed, as a tool for stakeholders to provide their input and suggestions to the project and for railway education at large.

The interviews would have concentrated on identifying both quantitative demands and qualitative preferences placed by the industry, such as most desired majors. However, it was considered as time-consuming and less flexible and therefore this option was excluded. On the other hand, an e-Forum aimed at maintaining continuous dialog and feedback on progress throughout the project was created as a part of the project website. Unfortunately, the e-Forum created has not experienced a significant interest.

Therefore, for the purposes of this discussion the idea of a targeted (ad hoc) industry survey using an appropriate tool has been embraced.

(v) A targeted (ad hoc) industry survey to define the need for higher educated professionals by the railway industry in the US and EU has been conducted using Super-Survey online platform. Super-Survey is a reliable and practical tool for data collection through questionnaires. One is able to build, manage and tabulate web surveys with easy. Our experience shows that Super-Survey is a very user-friendly platform.

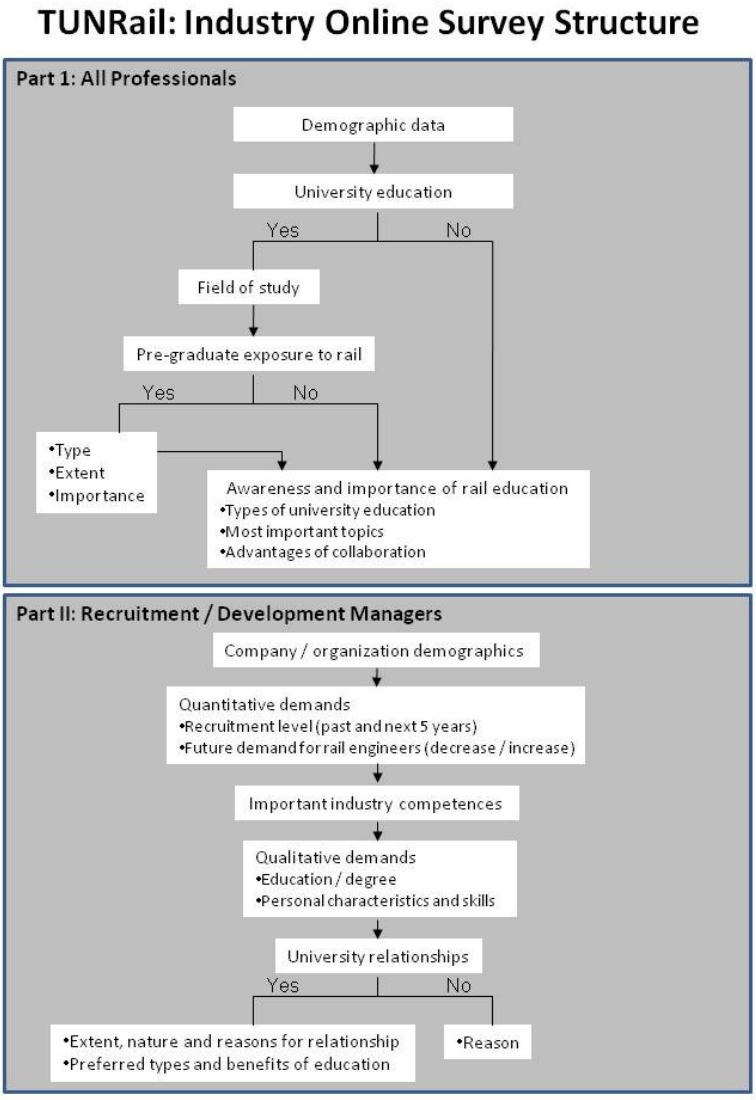

Illustration 3: Graphical Presentation of the Industry Survey Structure

The targeted (ad hoc) industry survey was named “Industry Survey”. The Industry

Survey consisted of two separate parts. The first part was envisaged to take only 5 minutes to fill in and was targeted to all rail industry professionals and concentrated on learning more about them as individuals, their background and paths to the industry and their opinions on the importance of university participation on the field, while the second and more extensive part was mainly targeted for managers of younger professionals and those involved in recruitment and training.

The structure of the industry survey is presented in Illustration 3 above.

More specifically, the first part of the industry survey contained 15 – 20 questions and aimed to collect information for the surveyee's company, educational background of personnel and exposure to railway education. Some of the questions asked were as follows:

- ✓ What is your educational background? And Graduation Major;
- ✓ In your Country, are you aware of railway education provided by universities?
- ✓ Do you think that employees with university education in: rail operations and management, rail infrastructure engineering, railway economics, etc. would add value to your organization?

The second part of the industry survey encompassed 35 – 45 questions, aimed at obtaining data for personnel education level, under performance, recruitment strategies and perspectives in railway-focused companies and therefore touched upon topics, such as: quantitative and qualitative demands for university graduates in the rail industry, core competencies required from the industry professionals, and input on university education topics and industry-university relationships. Some of the questions asked were as follows:

- Please indicate (in proportion) the education level of your organization's employees, only considering the employees working mainly in the railway activities;
- Can you please detail the main areas of under performance of the recently recruited employees with undergraduate level?
- Overall, do you expect the number of rail related positions within the next three years to: Increase; Decrease; or Stay the Same?;

Both parts of the industry survey received a significantly higher response rate.

Next steps of the stepwise methodology employed encompass aspects related to selection and implementation of an appropriate method for analysing the data collected. More specifically the following steps are envisaged:

(vi) Coordination with data collection to obtain proper dataset for comparative and evaluative analysis;

(vii) Selection of appropriate comparative/evaluation methods (such as benchmarking, statistical methods, ranking methods, Data Envelopment Analysis, etc.) including introduction to the selected method(s) and justification for the selection;

(viii) Implementation of the selected method(s) to perform benchmarking and comparative/evaluation analysis;

(ix) Comparison of quantitative and qualitative demand and supply for railway higher education and evaluation of the current programmes to sufficiently fulfil the demand;

(x) Identification of the synergies between the railway systems and railway higher education programmes in the US and EU.

Up to now we have completed steps (i) through (v). Steps (vi) through (x) remain to be fulfilled and therefore we shall not discuss them further in this paper. Instead, we present interim results obtained from the University Survey and the Industry Survey in the following section.

5 Interim Results

5.1 Analysis of Results obtained from University Survey

In 2010, there were only two official rail university programmes in the US with a third one projected to begin in 2011 and multitude of such university programmes in the EU. In addition to the two universities with official programmes, there are several universities in the US with rail education related activities. Table 2 provides a high level comparison of US and EU universities with rail programmes and/or with rail activities.

Next, Table 3 summarizes our findings for Railway Transport and Engineering Course Offerings on both sides of the Atlantic.

Description	US	EU
Number of universities with railroad programs (research and teaching combined)	2	21
Number of universities with railroad research activity	19	21
Number of universities with railroad courses	12	21

Table 2: High Level Comparison of US and EU Universities with Rail Programmes or with Rail Activities

We collected data for 21 university railway programmes with 260 railway courses across Europe. While not yet completed, the database already provides a very good overview of the current situation of higher railway education in Europe.

Figure 1 shows percentage of railway courses by subject in Europe. Note that the highest percent belongs to Railway Infrastructure, followed by Railway Operations and Rolling Stock and Traction.

Next, Figure 2 shows percentage of railway courses by country. It should be noted that the highest percent belongs to Germany.

From the collected data, the following statements can be made:

1. There are a very limited number of rail academic programmes and course offerings in the US. What is observed is that most rail courses in the US are at introductory level;
2. The biggest number of university railway programmes is found in the German-speaking part of Europe. There, for more than 100 years, railway engineering has been a regular part of the curriculum in civil engineering and transport engineering;

Description	Information: US	Information: EU
Example course topics	Railroad Track Engineering and Design Railroad Operations and Management Railroad Planning and Design Intermodal Freight Transportation Public Transit	Railway Infrastructures Railway Operations Management Railway Signalling Rail Transport Economics Railway Vehicle Engineering Fleet Management
Number (range) of students enrolled in courses	3-15(graduate) 10-40 (undergraduate)	10-20 (graduate) 20-200 (undergraduate)
Average number of railway courses offered per year (total for US)	10	260
Examples of collaboration with the railway industry	Railway industry funding Sponsored Research projects Official partnerships with financial support Internships Field trips for classes Development of classes Guest speakers	Railway industry funding Sponsored research projects Official partnerships with financial support Internships Field trips for classes Guest speakers / professors from industry

Table 3: Summary of US and EU Railway Transportation and Engineering Course Offerings

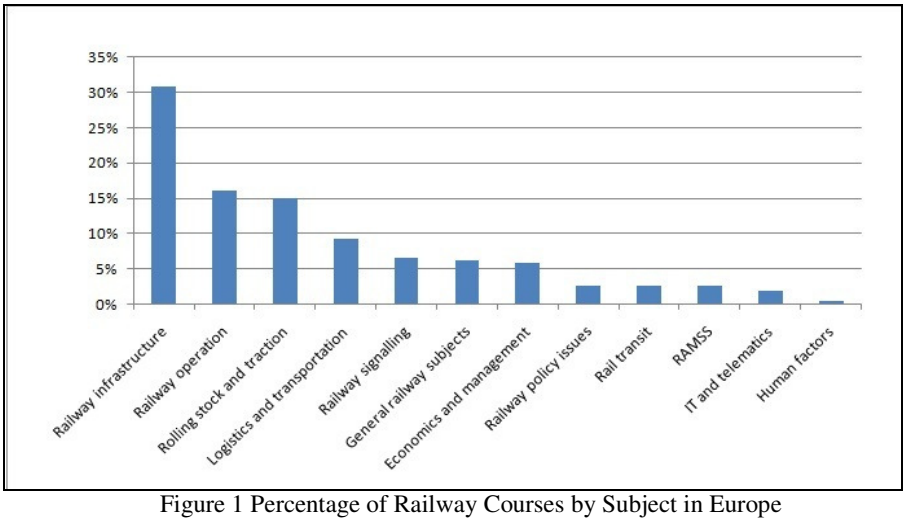

Figure 1 Percentage of Railway Courses by Subject in Europe

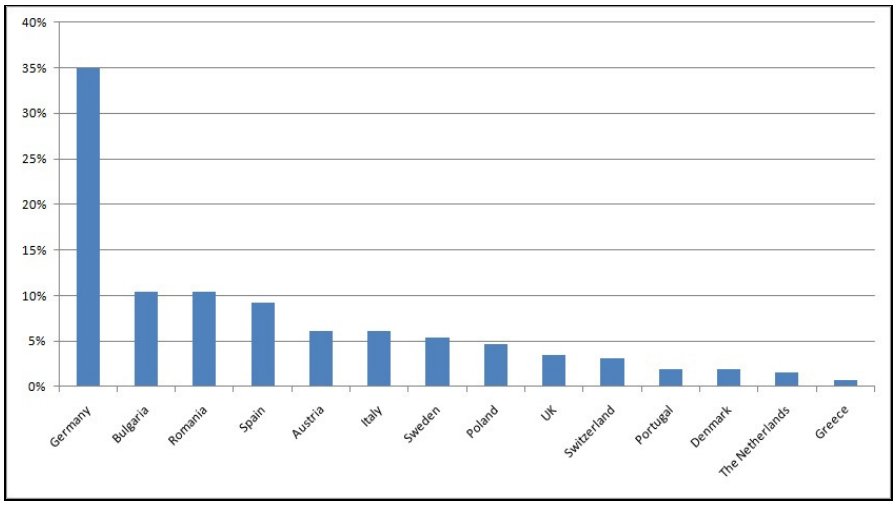

Figure 2. Percentage of Railway Courses by Country

3. In some Western European countries, university education in railway technology hardly exists. While research is done in the railway field, railways never became an important subject of teaching;
4. While the total number of university railway programmes in Eastern European countries is quite low, the existing rail education programmes are extremely comprehensive with an impressive number of courses offered. Both the number of enrolled students and the number of teaching staff involved in railway education is much greater than in any Western European country.

The situation we have today is a direct result from the different political development in the last 50 years. Before the political change in Europe in the early 1990s, in West Europe, apart from the German speaking countries where railway programs were established at many universities at the beginning of the 20th century, higher railway education didn't play an important role. Even in some of the bigger countries, e.g., France and the UK, university railway programs were practically non-existent. In these countries, the railways hired university graduates from general engineering programs, mainly from civil and mechanical engineering. New engineers were put into trainee programs offered by the railways. In some countries, these railway trainee programs took several years and included comprehensive courses and examinations. For that purpose, some railways established extensive academies. The teaching was often done by experienced railway engineers that did the teaching job on a part time basis.

In Eastern Europe, the situation was completely different. In the years after the Second World War, these countries adapted the Russian model of having highly specialized universities and colleges (sometimes referred to as the 'academy model'). In Russia, there were and still are pure railway universities. While the East European countries didn't follow that approach up to this extreme extent, they established transportation universities and colleges at which the higher education in transportation of a country was concentrated. Typical examples are the transportation colleges in Dresden (East Germany), Žilina (Czechoslovakia), Györ (Hungary), and Sofia (Bulgaria). In Poland and

Romania, instead of establishing separate transportation universities, transportation departments were installed at existing technical universities. These transportation colleges and transportation departments worked in a close cooperation with the national railways. They produced 'ready to run' railway engineers that could start their railway jobs directly after graduation without need for additional training. That is, why the East European railways never established extensive training programs like their Western counterparts.

In the 1990s, after the end of the Soviet empire, some East European countries kept this model while others didn't. In Dresden, the former college of transportation became a department of the Dresden Technical University. They still offer a comprehensive railway program. The transportation colleges in Žilina (now Slovakia) and Györ were transformed into general universities and no longer specialised in transportation. As another example, in Romania and Bulgaria, the comprehensive railway programmes still exist.

Despite all the changes in the last two decades, a uniform system of higher railway education does not yet exist in Europe. There are still significant differences between individual countries and groups of countries.

5.2 Analysis of Results obtained from Industry Survey

To date, the Industry Survey received approximately 600 responses. Based on the initial analysis:

- 85% of respondents are male, and 15% female;
- More than 50% are from US, the rest from EU and the rest of the world ;
- More than 50% of responses come from civil, mechanical or electrical engineers.

The outcomes of responses are summarised, as follows:

- 30% of respondents gained rail exposure either before university or at the university, which is a relative low percent;
- 50% of those respondents said that exposure to railway education played major role in career decision;
- 76% of respondents believe university education in railway operations and management would benefit their company, which may suggest that railways experience operations and management difficulties;
- 57% of respondents declared that their company collaborates with institutions that provide rail higher education;
- 70% of respondents believe that increasing university collaboration would benefit industry in recruitment, R&D, and innovation / creativity;
- 72% of respondents believe that more people will work in railway positions in their company three years from now, which indicates a significant potential for railway higher education in the future;
- 90% of the respondents agree that trans-Atlantic collaboration would benefit the railroad industry;
- In 58% of the companies the number of employees involved in rail activities increased;
- And 72% of the respondents believe that the number of employees will increase in the next three years;
- 41% of the respondents considered absolutely essential employees in rail activities to have a university grade;
- 35% of the companies have relationships or special agreement with Universities (undergraduate courses) in the field of railways;

-33% of the respondents believe that university current courses are adequate for addressing the key competences in rail activities.

6 Conclusions, Forthcoming Activities and Further Research

6.1 Conclusions

The analysis conducted so far reveals that comparison of data is challenging, due to different structure, extent and emphasis of the rail education programmes on both sides of the Atlantic.

In general, the US has a very limited number of academic programmes and course offerings and most of the rail courses are at introductory level.

Despite the fact that multitude of universities in the EU with rail education and research related activities exists, there is no a uniform system of railway higher education in Europe. There are still significant differences between individual countries and groups of countries in the EU.

Industry survey reveals the profile of current industry employees. It indicates a significant number of male employees working for the rail industry. Also it suggests an expected increasing demand for railway professionals within the next three years. This suggests that there is a potential for railway higher education in the future. More detailed analysis and comparison between responses from US versus EU shall be conducted to identify differences, opportunities and synergies.

6.2 Forthcoming Activities

The TUNRail project is halfway its lifetime. So far, the activities were essentially focussed on collecting information from the industry and universities. Currently the collected information is being analysed and digested. These tasks are being finalized now. The actual research work is about to begin. The research will follow three vectors, as follows:

1. Identification of the core competences of a railway employee;
2. Identification of the most successful rail education practices in European Union or the United States;
3. Identification of key curricula for rail higher education and courses.

The core competences of the railway employee will be assessed through a statistical cross comparison between the US and EU respondents. For the most successful rail education practices, a few cases will be selected and the key curricula assessed using an appropriate instrument [2]. The instrument should use information from the course syllabus, such as: objectives, contents and assessment scheme, to produce indicators for characterising its coherence.

6.3 Further Research

The following section discusses topics for further research. Over the past decades the railway sector has undergone major changes, particularly in the EU with the implementation of several legislative packages [3], [4]. In parallel, the technological development has rendered new technologies for railway transport. We live in a stirring environment demanding for high standards, innovation and harmonization. There is a

challenge for universities to adapt to new conditions towards high standards, innovation and harmonization of educational practices. In the EU, the implementation of Bologna process, aiming to harmonise the higher education across all member states, is now spreading and introducing changes in universities' curricula and long term practices. There is a need to re-align the railway higher education with the actual competences of the market. The *Know-How* to produce an adequate curriculum and to arm students with competences is still limited. New teaching and learning strategies and techniques such as learner-centred instruction, problem-based learning, project-based learning, blended learning have been proposed recently. Yet, the actual effectiveness of new teaching and learning strategies and techniques are still unknown [3]. This situation creates opportunities for further research.

The railway sector is likely to change at fast pace in the future. The development of railway industry will dictate the future needs for educated candidates. US and EU railway industry are substantially different in terms of size, customers, structure, management, etc., which results in different needs, competences and educational practices. We aim to develop a joint curriculum and exercise mobility of staff and students between the participating higher education institutions. We cannot expect to develop a universal curriculum. We can produce adaptable and dynamic courses that change in function of demand.

References

[1] TUNRail Project web site, 2009, http://www.tunrail.info

[2] Gómez, P., González, M.J., Gil, F., Lupiáñeza, , J.L., Moreno, M.F., Rico, L., Romero, I. (2007) " Assessing the relevance of higher education courses", Evaluation and Program Planning, vol. 30, pp149–160

[3] COM (2004/144 final) Proposal for a Directive of the European Parliament and of the Council on compensation in cases of non-compliance with contractual quality requirements for rail freight services, 2004/0050 (COD).

[4] COM (2004/236) Commission Staff Working Paper: Proposal for a Directive of the European Parliament and the Council, amending Directive 91/440/EEC on the development of the Community's railways to gradually open up the market for international passenger services by rail, "*Extended Impact Assessment"*.

[5] Frick, T.F., Chadha, R., Watson, C., Zlatkovska, E. (2009) "Improving course evaluations to improve instruction and complex learning in higher education", Education Tech Research Dev, pp 1-22 *rs of English*, 2nd Edition, McGraw-Hill, New York, 1991.