

Article

A Successful Cooperation between Academia and Industry in Higher Rail Education: The Postgraduate Course in “Railway Infrastructure and Systems Engineering” at Sapienza

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Abstract: The aim of this paper is to describe the postgraduate course in “Railway Infrastructure and Systems Engineering” at the University of Rome “La Sapienza”, funded by rail companies operating in Italy. It represents a successful example of cooperation between academia and industry in the field of railway transport. The success of the program is attested by its placement (the 90% of the graduates find an employment within six months in the companies which support the course; this percentage reached the 98% in the last three editions) and by the fact that every year it receives many more applications (almost 400 last year) than the maximum number of students that can attend the course (30). The main factors that make this course successful are its multidisciplinary training and the very close collaboration between the University and partner companies. In fact, the program of each

module is designed both by academics and by managers of the companies in order to ensure an up-to-date teaching, which provides both the academic and the industrial point of view of any rail subject; this enables students to obtain a complete vision of the railway system, so to be able to work in any of the partner companies.

Keywords: railways; engineering; higher education; postgraduate course; academia; industry; cooperation

1. Introduction

The postgraduate course in “Railway Infrastructure and Systems Engineering” [1] is an annual course equivalent to 60 ECTS (European Credit Transfer and Accumulation System: a standard for comparing the study attainment and performance of students of higher education across the European Union and other collaborating European countries. One academic year corresponds to 60 ECTS credits that are equivalent to 1500–1800 hours of study, and one credit generally corresponds to 25–30 hours of work). Course entrance requirements are to have both a Bachelor and a Master degree in engineering, the first issued after a 3-year course equivalent to 180 ECTS and the second issued after a 2-year course equivalent to 120 ECTS. Almost any degree in engineering is admissible (transport, civil, environmental, mechanical, electrical, electronic, chemical engineering, *etc.*).

The postgraduate course in “Railway Infrastructure and Systems Engineering” is part of an integrated railway education path offered by the University of Rome “La Sapienza” [2], which includes also an international Master of Science in “Transport System Engineering” [3] entirely taught English and a Ph.D. course in “Infrastructure and Transport” with a specific curriculum in “Railway Engineering” (see Figure 1).

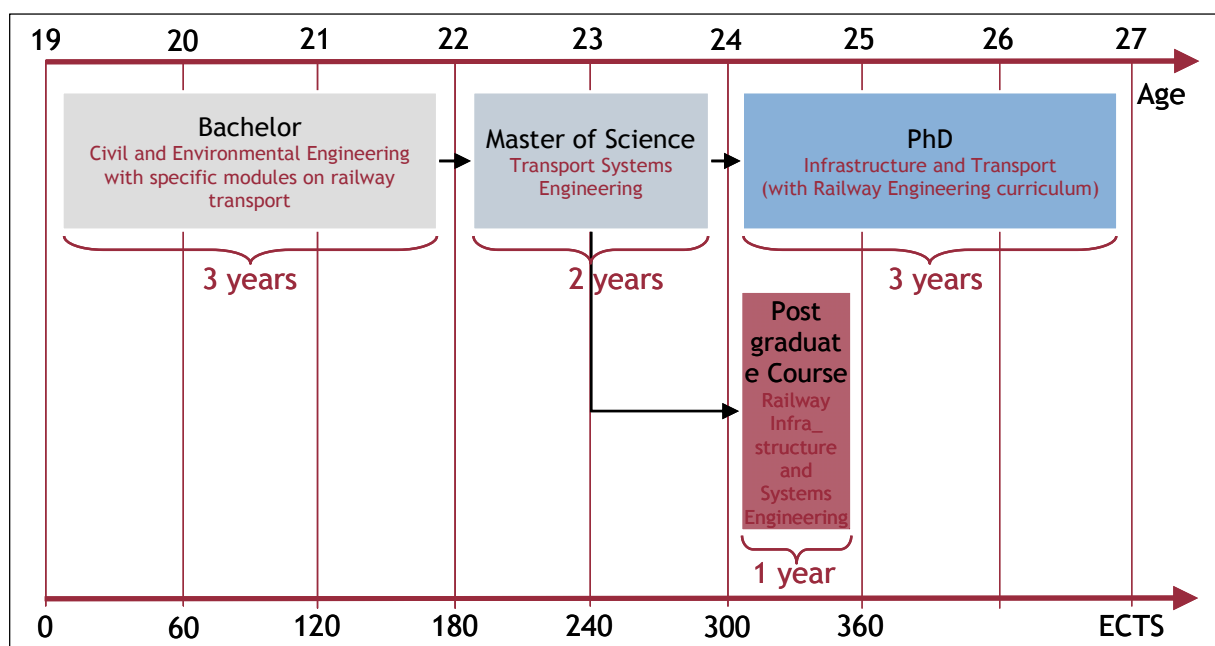


Figure 1. The integrated railway education path at the University of Rome “La Sapienza”.

The program in “Railway Infrastructure and Systems Engineering” at “La Sapienza” is designed to provide young engineers with the highest possible systemic railway know-how, through a multidisciplinary training which joins together technical, legal and economic subjects, since a railway engineer should be able to face both the specific topics and the connections between railway system components in order to optimize the whole system performances.

The aim of the course is to train engineers able to work, at the higher level, in government bodies, private companies and manufacturers which operate in railway sector, in particular the ones that fund the course.

2. Course Structure

The Course is an annual course equivalent to 60 ECTS. It is articulated in:

- 12 modules (each of them is equivalent to 4 ECTS) with theoretical lessons, seminars, tests and technical visits (at the end of each module students have to pass an exam);
- work experience of at least 150 hours (equivalent to 6 ECTS) at one of the Companies which support the Course;
- final examination (equivalent to 6 ECTS).

The Course requires full time involvement for 9 months. From the second half of January to the end of May it includes lessons every day from Monday to Friday; from the start of June to the end of July a period of internships at one of the companies which support the course; in September the module “exchange of internship experiences” and “final examination”.

The Course includes the modules listed in Table 1. It is possible to note how they cover a very wide range of topics in the field of railway engineering as a mark of the multidisciplinary of the course.

Table 1. Course modules and module’s content.

Module’s title	Module’s content
1. Principles of railway engineering	In this module students are provided with the fundamental elements necessary to face in a profitable way the study of railway transport.
2. Railway track and fixed installations	The aim of this module is to provide students with the basic elements of the railway track, fixed installations for electric traction, signaling and telecommunications.
3. Traction systems and vehicle dynamics	The aim of this module is to provide students with the basic elements of traction systems on board of railway vehicles and vehicle dynamics.
4. Infrastructure designing and planning	The aim of this module is to provide students with an overview of the main aspects of the design and construction of rail infrastructure.
5. Railway traffic technologies	The aim of this module is to provide students with principles and rules that govern railway traffic, carrying capacity of lines and stations, command, control and signaling systems.
6. Management of railway safety	The aim of this module is to provide students with theoretical principles of safety, risk analysis and its applications to rail transport, Safety Management Systems of railway operation developed by the different actors of rail transport (Infrastructure Managers and Railway Undertakings), technologies to ensure the safety of both railway lines and rolling stock.
7. Passenger and freight terminals	The aim of this module is to provide students with theoretical principles underlying the dimensioning and design of passengers and freight railway stations; case studies related to new stations, the upgrading of existing and the transformation of disused railway areas.

Table 1. *Cont.*

Module's title	Module's content
8. Freight transport and logistics	The aim of this module is to provide students with the basic elements of logistics, techniques of freight transport with particular reference to rail and multimodal transport, information systems to support rail freight transport, international regulations for the transport of dangerous goods.
9. Service planning and quality	The aim of this module is to provide students with the theoretical principles underlying the planning of transport systems in general and railway systems in particular, the timetable planning, quality management principles and their applications to rail transport; operational management of the rail traffic; rail transport costs assessment.
10. Public works planning and regulations	The aim of this module is to provide students with the main technical, regulatory, procedural and administrative issues related to the planning, design and construction of new railway infrastructures.
11. Corporate culture, economic and environmental evaluation of railway planning	The aim of this module is to provide students with the basic elements of skills and abilities to own for working in a company; main technical and legislative issues underlying the evaluation and assessment of interventions and the environmental impact assessment.
12. Exchange of internship experiences	In this module, students present the work they made during the period of internship at one of the Companies which support the Course to the other students, the University and Corporate Tutors and the HR Managers of partner Companies. Then they respond to any questions of their colleagues and others in the room.

3. Facts and Figures

Since the first edition (A.Y. 2003/2004), more than 270 students obtained the degree and the 90% of them found an employment within six months in the companies which supported the course; this percentage reached the 98% in the last three editions.

The success of the program is also attested by the fact that every year it receives many more applications (almost 400 last Academic Year, see Figure 2) than the maximum number of students that can attend the course (30) and it is necessary to select the admitted applicants by a selection process into two stages: a first evaluation of the curriculum on the basis of which the first 90 candidates are admitted to the subsequent oral entrance examination.

Entrance examinations are managed in cooperation between University and companies and include three kinds of tests: a technical test on the main engineering topics, an aptitude tests (developed by the HR Departments of the partner companies) and a test of English language proficiency.

The breadth of participation is evidenced by the fact that candidates send their applications from every part of Italy (see Figure 3) and they are graduates from almost all the Italian universities which offer Masters degrees in engineering.

It is interesting to notice that every year the largest number of applications come from southern Italy and the Islands, because in these areas the employment rate is lower than in the rest of Italy and the course is nowadays perceived by young engineers (the average age of the candidates admitted to the entrance examination is about 26 years) as an excellent opportunity to be employed in the railway sector.

The excellent quality of the application is attested by the high degree marks of candidates. For instance, last academic year, 154 of the 395 applications were by candidates who graduated with honors

(39%) and 57 of the candidates graduated with a degree mark of 110/110. Among the 90 admitted to the entrance examinations, 70 graduated with honors (78%) and 15 with a degree mark of 110/110; the lowest degree mark of admitted candidates was 105/110.

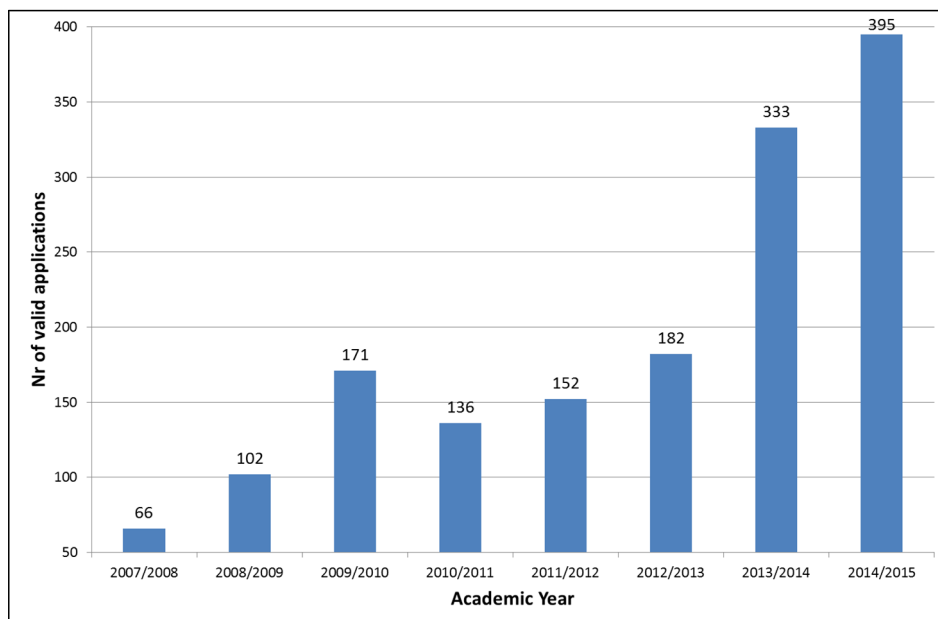


Figure 2. Progression of applications for admission to the course in the last eight editions.

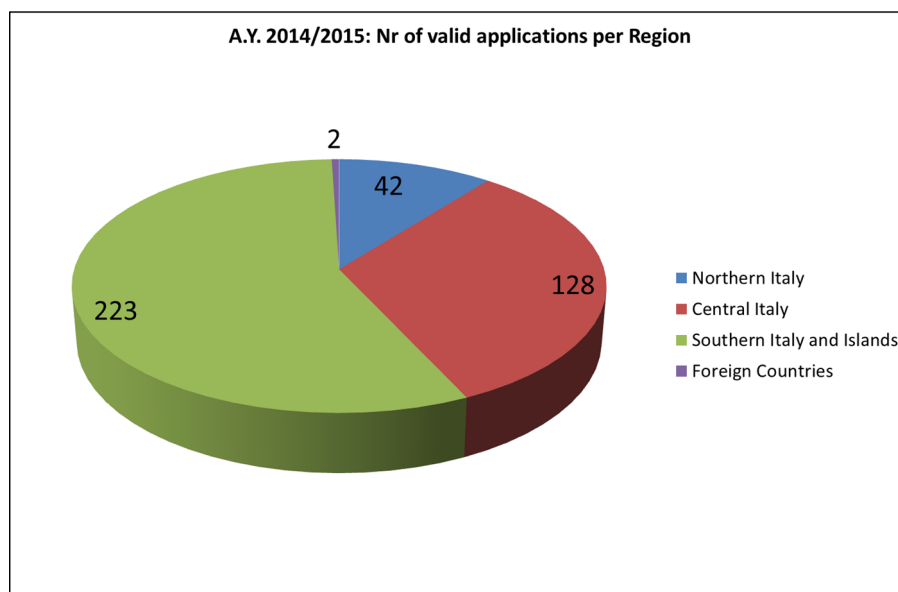


Figure 3. A.Y. 2014/2015: geographical distribution of the applications.

4. The Partner Companies and Their Contribution

The 11th edition (A.Y. 2014/2015) of the course is organized by the University of Rome “La Sapienza”, in cooperation with the following rail Companies operating in Italy (see Figure 4):

- Ferrovie dello Stato Italiane (FS Italiane), the largest Italian Railway Company, owning both the main Italian Infrastructure Manager (RFI—Rete Ferroviaria Italiana) and the main Italian

Railway Undertaking (Trenitalia) and other companies which support the course, such as Italferr and FS Sistemi Urbani (respectively the engineering company and the real estate company of FS Italiane Group) [4];

- AnsaldoBreda and Ansaldo STS, both Finmeccanica Companies operating in the global Railway and Mass Transit Transport Systems business, the first responsible for designing and manufacturing railway and mass transit vehicles and the second with the provision of traffic management, planning, train control and signaling systems and services [5,6];
- Bombardier Transportation Italy, the Italian Division of the global leader in the rail industry, which cover the full spectrum of rail solutions, ranging from complete trains to sub-systems, maintenance services, system integration and signaling [7];
- Almaviva, one of the leading company in ICT systems for transport [8];
- Roma Metropolitane, the company which designs and supervises the construction of the new underground railway lines in the city of Rome [9].

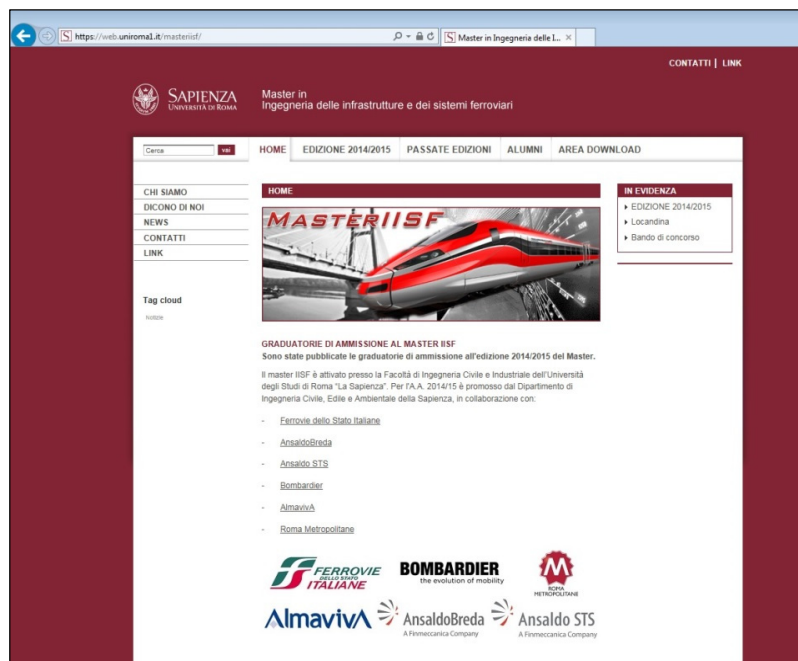


Figure 4. The homepage of course website in which the list of partner companies is shown.

Within “Sapienza” University of Rome, the DICEA Department is involved in civil, building and environmental engineering [10]. The transport area is one of the largest of the department’s nine areas and has a long tradition of teaching and research in the field of railway engineering, which cover a wide range of topics: operational and system performance; infrastructure design and maintenance; signaling systems; rolling stock; safety and environmental issues.

In particular, “Sapienza” is the only University in Italy which offers a Ph.D. course in “Infrastructure and Transport” with a specific curriculum in Railway Engineering and the DICEA Transport Area have been working for many years, also with Ferrovie dello Stato Italiane and other Companies, on several and prestigious research projects and consultancies in Italy, Europe and elsewhere.

Moreover, for many years there was a profitable teaching interchange between “Sapienza” Professors, which used to teach at vocational courses for Ferrovie dello Stato employees, and Ferrovie dello Stato, which used to host “Sapienza” students as interns for developing their degree thesis.

Thus, in 2003, when “Sapienza” organized the first edition of the course, the involvement of RFI—Rete Ferroviaria Italiana (the main Italian Railway Infrastructure Manager) was almost natural.

Then, over the years the course has gained increasing popularity and, almost without the need to promote it, several other companies (including the whole FS Italiane Group) have joined with enthusiasm.

There is a very close collaboration between University and companies which support the course:

- funding course activities;
- providing scholarships for students;
- providing their managers for the role of “module coordinator”: each module has at least two coordinators, one comes from University and one from Industry, which together define the program of the module, choose the lecturers and examine students at the end of the module;
- providing their managers for lectures (in each module about half the lecturers come from University and half from Industry);
- arranging technical visits to their control rooms, repair shops, factories and construction sites;
- providing a 2-month internship to students within the course period.

In fact, railway companies recognize the attractiveness of this course, which is a unique offer in Italian higher education, because there is no such a composite course concerning railway engineering with its many specializations. The railway sector, due to its complexity, requires a comprehensive systemic know-how from engineers.

Therefore, this program provides an opportunity for employers to have staff who have a good balance of diverse railway skills.

5. Conclusions

In the light of the previous description the main factors that make the cooperation between academia and industry in the course at DICEA successful are the following.

- Multidisciplinary training enables students to obtain a complete vision of the railway system and to be able to work in any of the partner companies.
- The program of each module is designed both by academics and by managers of the partner companies in order to ensure that all the subjects that Industries consider important are included in the course.
- The fact that in each module about half the lecturers are professors and half managers of the partner companies ensures an up-to-date teaching which provides both the academic and the industrial point of view of any rail subject.
- Managers of the partner companies take part also to the entrance examinations, to the examinations after each module and to the final examination, so that companies are able to judge students at every stage of the learning process.
- The period of internships at one of the companies which support the course both trains students to work in industry and enables the company to examine students carefully.

- The final module “Exchange of internship experiences” is a further stage in which companies can assess students, since at the presentation of their work of internships are present in addition to the company tutors and the HR Managers.
- Ultimately, thanks to this course, companies can evaluate the employment of young engineers who have contributed to select, train for 9 months in the railway sector with the cooperation of academia, and assess them at any stage of their training (including the period of internship). This allows companies to employ engineers already formed in the railway field almost without risk.

In this way it is possible for Sapienza to train young engineers in the railway sector in a very effective way and meet the demand for railway higher education from Italian Industry.

The main area of improvement, identified also by students, concerns the fact that it is not possible to deepen each course topic due to the multidisciplinary nature of the course and its contained duration (only 9 months including internship to enable off-site students to minimize costs).

Moreover, every year teaching must be updated to take into account the evolution of railway technology. As an example, some lectures on innovative thinking are already planned for the next edition of the course.

Author Contributions

The three authors from Sapienza University of Rome have contributed to the paper describing the aim, history, present structure, factors of success and main areas for improvement of the Course. Authors from the partner Companies have contributed describing the main factors which make the sponsorship of the Course profitable for their Companies.

Conflicts of Interest

The authors declare no conflict of interest.

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