

# **The Role of the Puerto Rico Transportation Technology Transfer Center in the Enhancement of Engineering Education**

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## **ABSTRACT**

The Puerto Rico Transportation Technology Transfer Center of the University of Puerto Rico at Mayagüez will celebrate this year its 25<sup>th</sup> anniversary serving the engineering education market in the Commonwealth of Puerto Rico and the United States Virgin Islands. This service has been accomplished at various levels including continuous education to engineers and technicians that are working for the transportation agencies and the municipalities, specialized education and professional development programs related to urban transit systems to students primarily from the University of Puerto Rico and coordination of special programs and activities to provide additional education opportunities to undergraduate and graduate students.

The continuous education has been provided through a comprehensive seminar program consisting of technical and supporting topics related to transportation related tasks. The specialized and professional development programs were related to the various phases of the construction of the “Tren Urbano” and to its operation in the Metropolitan Area of San Juan, Capital of Puerto Rico. This special transit program provided economic support to students through fellowships in order to create interest towards the transportation engineering profession and a market of highly trained engineers that could contribute in the enhancement of the specialized transit field. This paper provides a general description of the Puerto Rico Transportation Technology Transfer Center and a detailed description of the various activities that have contributed to the enhancement of engineering education.

**Keywords:** Engineering education, fellowships, professional development, technology transfer, and transit.

## **1. INTRODUCTION**

The Puerto Rico Transportation Technology Transfer Center (referred herein as PR-T<sup>2</sup> Center) was created on April 1, 1986 in the Civil Engineering Department of the University of Puerto Rico at Mayagüez as part of the Federal Highway Administration (FHWA) Rural Technical Assistance Program (RTAP) that emphasized technical assistance to local transportation officials in rural communities. The objectives of the PR-T<sup>2</sup> Center in its inception in 1986 were to (Colucci and Luyanda, 2006):

- Transfer the significant findings of research studies that were conducted in the United States and abroad to local municipalities in Puerto Rico and the United States Virgin Islands in a concise format.
- Train highway personnel in areas related to new construction and rehabilitation techniques, maintenance strategies, and pavement management.
- Keep local highway and municipal officials current with the new technology already available in the areas of design, construction, programming, maintenance, evaluation and rehabilitation.

With the enactment of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, the program became known as the Local Technical Assistance Program (LTAP) and included technical assistance to urban

areas with an expansion of the network to 58 Centers (one in each state of the United States of America, seven in tribal communities and our Center).

The PR-T<sup>2</sup> Center has fully accomplished its initial goals and objectives and has evolved significantly with other projects and activities maximizing its strategic location within a university setting in the Caribbean, our access to students and faculty members from various disciplines and campuses, our bilingual capabilities, and the ever changing local and international transportation needs. These other activities have included special short-term projects to complement the technology transfer activities and other activities related to the professional development of students, the planning and coordination of local, national and international conferences, and the provision of international technical assistance. This rest of this paper provides a description of the principal Center's activities and the other innovative projects that have contributed to the engineering education.

## 2. CENTER ACTIVITIES AND SPECIAL PROJECTS

The principal activities of the Center are its seminar program, the publication of a bilingual newsletter, the provision of technical information services, the participation in short-term special projects and the evaluation of the effectiveness of the training program.

### 2.1 SEMINAR PROGRAM

The principal activity of the PR-T<sup>2</sup> Center is the seminar program for local transportation officials from the 78 municipalities of the Commonwealth of Puerto Rico, the Puerto Rico Department of Transportation and Public Works (PR-DTPW) and the Virgin Islands Department of Public Works (VI-DPW). The annual training program has included at least 40 seminar-days in Puerto Rico and 10 seminar-days in the United States Virgin Islands (USVI).

The seminar program includes technical seminars and supporting tool-related seminars. Technical seminars correspond to topics of technical nature related to transportation, such as pavement design methodologies and construction procedures, pavement evaluation and maintenance techniques, management of transportation projects, material testing and selection procedures, safety evaluation and analysis of highway facilities, traffic engineering, and development of geographic information systems. Figure 1-A present's one of our instructors teaching a hands-on seminar on the fundamentals on concrete materials testing, whereas in figure 1-B a demonstration of the capabilities of a new generation of truck mounted attenuators is shown Civil Engineering Department at the UPRM.



**Figure 1: Technical Hands-on Seminars Offered to Transportation Officials.**

Supporting tool-related seminars include topics that complement routine transportation-related activities such as introduction to microcomputers, introduction to spreadsheets and databases, basic management concepts, ethics for engineers, basic statistics, basic supervisory skills, tort liability, and guidelines in technical writing.

## **2.2 EL PUENTE NEWSLETTER**

The PR-T<sup>2</sup> Center publishes "El Puente" (The Bridge); a bilingual newsletter (in English and Spanish) that serves as a bridge of information between the Center and the local transportation officials and as a vehicle for reader response. The current newsletter format keeps municipal and other transportation officials informed about the latest transportation-related technology, the latest technical publications and audio-visual materials available at our library, and the topics and dates of the training opportunities sponsored by the PR-T<sup>2</sup> Center.

## **2.3 TECHNICAL INFORMATION SERVICES**

The PR-T<sup>2</sup> Center maintains a transportation-related library that provides technology transfer materials in the form of technical publications and videotapes to municipalities or transportation officials. The library includes over 1,500 research reports, technical magazines, transportation and highway engineering textbooks, proceedings of transportation-related conferences, and catalogues of information services that assist in the acquisition of technical information not available at the PR-T<sup>2</sup> Center. This library is complemented with newsletters from other LTAP Centers, and journals and other publications from the Transportation Research Board (TRB) and the Institute of Transportation Engineers (ITE), among other institutions.

The PR-T<sup>2</sup> Center has developed an audio-visual technical library that currently consists of over 500 videotapes in VHS, CD or DVD formats (80% of the materials are in English and approximately 20% in Spanish). The topics include administration and management, asphalt, bridges and structures, design and construction, equipment and vehicles, geotechnology, drainage, maintenance and operation, pavements and traffic safety.

The PR-T<sup>2</sup> Center also provides technical information services to municipalities as requested through its web page ([www.uprm.edu/prt2](http://www.uprm.edu/prt2)). The information provided is in terms of advice, guidance, or referral to published materials, new video releases associated to transportation issues and other relevant areas associated to the built transportation infrastructure in Puerto Rico and the US Virgin Islands. The web page also includes links to other web pages, newsletter articles, upcoming events and tips/checklist of interest to our local stakeholders. Telephone, letter and electronic mail are also used to handle any request. In certain cases, the requests could be used to develop a seminar topic of interest to other officials from the municipalities.

## **2.4 SPECIAL PROJECTS**

The PR-T<sup>2</sup> Center has participated in short-term projects of interest to all the municipalities, the PR-DTPW, and the VI-DPW to complement its technology transfer activities. Some of these special projects are:

- Development of transportation-related microcomputer software tools.
- Translation to Spanish of technical material of transportation-related topics.
- Spanish translation of the Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects.
- Development of guidelines for the municipalities on how to prepare Request for Proposals related to public transportation projects.
- Development of technical videos regarding the proper use of asphalt, concrete, and soils in road and bridge construction.
- Development of technical guidelines for traffic control in highway temporary work zones.
- Participation in the USDOT-FHWA Strategic Highway Research Program (SHRP) Assessment Project regarding the documentation of successful stories associated to the implementation of safety products in highway construction zones, and the inventory of existing pavement distresses.
- Development of special seminars on the American with Disabilities Act (ADA).
- Identification of transportation needs of municipalities through site visits and questionnaires.
- Surveys to determine the need of municipalities with a population of less than 50,000 people.
- Evaluation of existent transportation facilities and evaluation of marketing methods to promote public transportation in municipalities with a population of less than 50,000 people.

## **2.5 PROGRAM ASSESSMENT**

The effectiveness of the training program is evaluated on a continuing basis with the evaluation forms distributed in each seminar and with the comments received from members of the Advisory Committee and the participants of the PR-T<sup>2</sup> Center's activities. In addition, continuous feedback from customers not involved in our seminar program is received through the web page. Through this mechanism and following the guidelines of the Strategic Plan of the National LTAP Association, the evaluation of the effectiveness of the program is a continuous process. The LTAP Centers collect data of each calendar year and submit this information to FHWA in two quantitative tools known as Program Assessment Report (PAR) and Center Assessment Report (CAR). These reports provide both FHWA and program stakeholders with an up-to-date view of the quality of the LTAP/TTAP program and its impact on the surface transportation community.

The CAR addresses specific success and challenges, general program and center management and overall program and center management. The PAR includes data of the major activities conducted by the PR-T<sup>2</sup> Center that are associated with the performance measures incorporated in the PR-T<sup>2</sup> Center's Strategic Plan. The four (4) focus areas are listed below:

- Safety
- Infrastructure Management
- Workforce Development
- Value Delivery

During calendar year 2010, an excess of 2,565 participant-hours have been devoted to highway safety, 1,380 participant-hours to worker/workplace safety training, 4,519 participant-hours to infrastructure management training and 1,632 participant-hours to workforce development, management/leadership and soft skills. During the 25 years of the PR-T<sup>2</sup> Center, over 24,500 transportation officials of Puerto Rico and the USVI have participated in the training program.

## **3. INNOVATIVE PROGRAMS THAT HAVE CONTRIBUTED TO THE ENGINEERING EDUCATION**

In addition to the PR-LTAP program, the PR-T<sup>2</sup> Center has participated in pioneering initiatives that have enhanced the engineering education and the development of the transportation workforce at the local and international level. These innovative programs associated with professional development and community service administered through the PR-T<sup>2</sup> Center are described below.

### **3.1 UPR/MIT/TREN URBANO PROFESSIONAL DEVELOPMENT PROGRAM**

The University of Puerto Rico (UPR), Massachusetts Institute of Technology (MIT), Tren Urbano (TU) Professional Development Program was in operation since the summer of 1994 and was transferred to the PR-T<sup>2</sup> Center in 1999. During the ten years of the program its main focus was the development of future transportation workforce and research mainly devoted to the planning and construction activities of the TU, the heavy rail mass transit system and largest transportation infrastructure project constructed in the San Juan Metropolitan Area (SJMA).

Undergraduate and graduate students from different disciplines learned the importance of analyzing and evaluating all aspects of a transportation project, such as engineering, transportation systems, architecture, social factors, urban planning, safety, and public participation. Students were exposed to a multidisciplinary setting that promoted the interaction among professionals, exposition to the latest technologies, global impacts, ethics and professionalism, contemporary issues, and communication skills, and allowed them to apply their knowledge in mathematics, science, and engineering to conduct experiments, and to identify, formulate and solve engineering, architectural and planning problems. (Colucci et al., 2001 and Colucci and Gutiérrez, 1999)

The success of the Tren Urbano / UPR / MIT Professional Development Program relied on the employment of a team approach toward problem-solving between members of the academia, researchers, and the private and public sectors that made it a true technology-sharing component of the TU. The program consisted of five elements: university courses on public transportation specifically design for this innovative project, research projects developed by the students, summer hands-on work internships, site visits to TU construction sites and to an operating urban rail transit system, and potential post-graduation employment with TU consultants and contractors. Figure 2-A shows one of the key program elements, namely interdisciplinary team students inspecting a construction site of one of the Tren Urbano station whereas in Figure 2-B students and faculty mentors are evaluating the operation characteristic one of the Tren Urbano station recently inaugurated.



**Figure 2: Participation of Students and Faculty Mentors in Professional Development Programs.**

Over 300 research projects were developed in this successful initiative in partnership with MIT and other supporting universities. Many students that participated in this program have been employed by Alternate Concepts Inc. (the firm operating the TU), “Alternativa de Transporte Integrado (ATI)” Office (the government office in charge of supervising the TU operation and its integration to other transportation modes), local government transportation offices, and private consultant firms.

### **3.2 UPR/PUPR/ATI PROFESSIONAL DEVELOPMENT PROGRAM**

The UPR/PUPR/ATI Professional Development Program was administered by the Center from the summer of 2004 until 2007. This program involved the UPR Mayagüez and Río Piedras Campuses, the Polytechnic University of Puerto Rico (PUPR) and ATI through the Puerto Rico Highway and Transportation Authority (PRHTA).

In this innovative interdisciplinary-multicampus program, undergraduate and graduate students with faculty mentorship from the three campuses learned about the interaction among professionals and focused on the integrated operation of the TU. This program was similar to the earlier UPR / MIT / TU Program with a new emphasis on analyzing the effectiveness of the SJMA public transportation system since the TU started operations, and the many impacts the TU is having on the SJMA and on its integration to other public transportation modes. Figure 3 presents one of the program elements with a group of our students visiting the Portland TRI-MET system to learn about its history and operation to transfer those experiences to the ATI and TU in Puerto Rico. Over 80 research projects were completed as result of this initiative.



**Figure 3: UPR / PUPR / ATI Group 3 Exploring The Portland Tri-Met Transit System.**

### **3.3 DWIGHT DAVID EISENHOWER TRANSPORTATION FELLOWSHIP PROGRAM (DDETFP)**

The Dwight David Eisenhower Transportation Fellowship Program was established by the Intermodal Surface Transportation Efficiency Act (ISTEA). (Colucci et al., 1999) The objectives of this program are to:

- Attract the nation's brightest minds to the field of transportation,
- Enhance the careers of transportation professionals by encouraging them to seek advanced degrees, and
- Retain top talent in the transportation industry.

This fellowship program helps upgrade the scope of knowledge of the entire transportation community in the United States and encompasses all transportation modes. The purpose of the Eisenhower Graduate Transportation Fellowships is to sponsor people interested in pursuing a Master's or Doctorate (or equivalent) degree in a field of study directly related to transportation. In response to the Nation's goal of improving highway safety and reducing fatalities, additional consideration is given to studies and research related to the analysis of crash data and human factors, crash countermeasures selection, roadway and roadside design, and safety improvement programs, among other topics.

Within the Eisenhower Transportation Fellowship Program there is a component directed at identifying talent from Hispanic Serving Institutions (HSI), including the UPRM campus. The PR-T<sup>2</sup> Center has been administering the program since 1994, benefiting over 50 students, many of which are current leaders within the local transportation field.

### **3.4 ENTREPRENEURIAL TRAINING AND TECHNICAL ASSISTANCE PROGRAM (ETTAP)**

The PR-T<sup>2</sup> Center, with the collaboration of the Office of Small and Disadvantaged Business Utilization (OSDBU), participated since 1997 until 2002 in ETTAP. This program, through partnership agreements with Minority Educational Institutions (MEIs), including HSI and Historically Black Colleges and Universities, combined the efforts of MEIs, government, and the private sector to focus on providing transportation-related assistance and procurement information to small, women-owned and disadvantaged business. ETTAP focused on three transportation-related areas: (Colucci et al., 2001)

- Training and technical assistance on the use of and access to electronic commerce and the Internet,
- Transportation-related student internships,
- Information dissemination and outreach activities regarding the Presidential Welfare-to-Work Initiatives to hire individuals off the welfare rolls and to support the USDOT Garrett A. Morgan Technology and Transportation Future Programs.

ETTAP provided training and development to students in K-12 levels in transportation-related fields through the use of internships and fostered interdisciplinary opportunities for students in the field of transportation. Figure 4 presents one of the interns giving a transportation-related seminar to middle-school students. The ETTAP program agreement increased the skills and understanding of technical issues and research skills of students, including students with disabilities, promote and encourage the participation of students with disabilities in transportation-related contracts and fostered interdisciplinary opportunities for college students in the field of civil engineering with emphasis in transportation.



**Figure 4: ETTAP Intern Giving a Transportation-Related Seminar to Middle-School Students.**

### **3.5 HOUSEHOLD SURVEY CONDUCTED BY THE ENGINEERING STUDENTS AS PART OF EPICS PROGRAM**

The PR-T<sup>2</sup> Center director and the UPRM Department of Civil Engineering and Surveying, in collaboration with Purdue University, participated in the EPICS Program (Colucci et al., 2001). EPICS is an innovative program that creates partnerships between teams of undergraduate students and non-for-profit local community organizations to solve engineering-based problems in the community. During the years 2002 and 2003, engineering students worked in collaboration with students from the Department of Social Sciences, Humanities and other disciplines from the UPR Mayagüez and Aguadilla Campuses, and with the University Institute for the Development of the Communities, in community service projects in over 35 communities of the western region of Puerto Rico. Figure 5 present one of our engineering female students conducting “informal household surveys” to address the emerging needs of the Special Communities, with low income in our Island. The engineering students were part of an interdisciplinary team evaluating potential engineering projects for these needed communities.



**Figure 5: Engineering Community Service Activity.**

Surveys, inspections documenting deficiencies in the built infrastructure, and coordination of social activities to improve the self-esteem of the community were conducted. Posters and technical oral presentations were made by the students to the communities and to local transportation officials, of which many of the recommendations have been implemented.

### **3.6 SUMMER EXCHANGE INTERNSHIP PROGRAM**

The PR-T<sup>2</sup> Center as part of UPRM, has participated in a Summer Internship Experience with the University of Rhode Island (URI), since 2004. The Summer Exchange Student Program is sponsored by the URI Transportation Center and the Dwight David Eisenhower Transportation Fellowship Program of the FHWA. Students from URI conducted research work in Mayagüez under the supervision of professors from the UPRM College of Engineering in areas associated with engineering related topics such as fiber reinforced materials, landslide-prone sites, vehicle-pedestrian crashes/highway safety, improvement in text and video information in variable message signs through simulation and geotechnical engineering laboratory characterizations. The exchange program provides a new arena to learn from other faculty researchers, different culture and traditions,

and help them to become independent and to develop other soft skills that are required to become a successful professional in engineering and transportation-related disciplines.

### **3.7 NATIONAL AND INTERNATIONAL COLLABORATIONS**

The PR-T<sup>2</sup> Center has collaborated with international organizations and governments to provide information on the FHWA Transportation Technology Transfer Program and the Puerto Rico public transportation system, including the characteristics of the “Público” system and the Tren Urbano. Several of these national and international collaborations are:

- The “Congreso Panamericano de Carreteras” (COPACA) in 1988 requested several presentations in Buenos Aires, Argentina, about the Rural Technical Assistance Program (RTAP) and specifically about the tasks, organizations and accomplishments of our Center to consider extending the transportation technology transfer concept throughout Latin America.
- COPACA and the FHWA in 1988 requested the assistance of the Center’s Directors in the Founder’s Conference of the Pan-American Institute of Highways that was held in Phoenix, Arizona. The participation of the Directors, due to their bilingual capabilities, was instrumental in the development of formal documents that led to the creation of the PIH that extended the RTAP concept to countries in the Caribbean and South America.
- The Federal Transit Administration in 1990 requested the assistance of the Center’s Directors to provide technical information on the Puerto Rico “Público” system to the government of South Africa since the kombi system was experienced major operational problems. Presentations were made in South Africa to government officials from their Department of Transportation and professors from the University of Pretoria.
- Since 1996, due to involvement of the Center’s Directors in the UPR/MIT/TU and UPR/PUPR/ATI Professional Development Programs, the “Asociación Latino Americana de Metros y Subterráneos” (ALAMYS) has invited professors to participate in its Annual Conference held in Latin America cities. Presentations have been made regarding the SJMA public transportation system that led ALAMYS to accept the PRHTA as a full member of this prestigious organization.
- The Center has organized regional and national conferences as part of the LTAP network of Centers sponsored by the Federal Highway Administration, and international conference such as the 1995 NASTO-CoHemis Transportation Research in the Americas sponsored by the National Science Foundation.

### **3.8 RECENT ACTIVITIES**

Since 2006 the PR-T<sup>2</sup> Center has collaborated in various activities that have continued to enhance the engineering education. These have included:

- Participation in the Automobile Accident Compensation Administration (ACAA, for its acronym in Spanish) Summit of Highway Safety where the Center’s Directors made technical presentation on highway safety topics emphasizing the behavior of local drivers and the characteristics of the Puerto Rico highway system.
- A special project on motorcycle safety with the Puerto Rico Traffic Safety Commission.
- Organization of a summit where organizers and leaders presented their plans for the success of the Mayagüez 2010 Central American and Caribbean Games.
- Collaboration with CoHemis in the Planet Earth Week.
- Organization of the Transportation Week Fair.

### **3.9 SUMMARY OF ACTIVITIES**

The principal activities that the PR-T<sup>2</sup> has participated in the last 25 years, that has proven to be successful in engineering education and previously discussed, are shown in a chronological sequence in Figure 6.



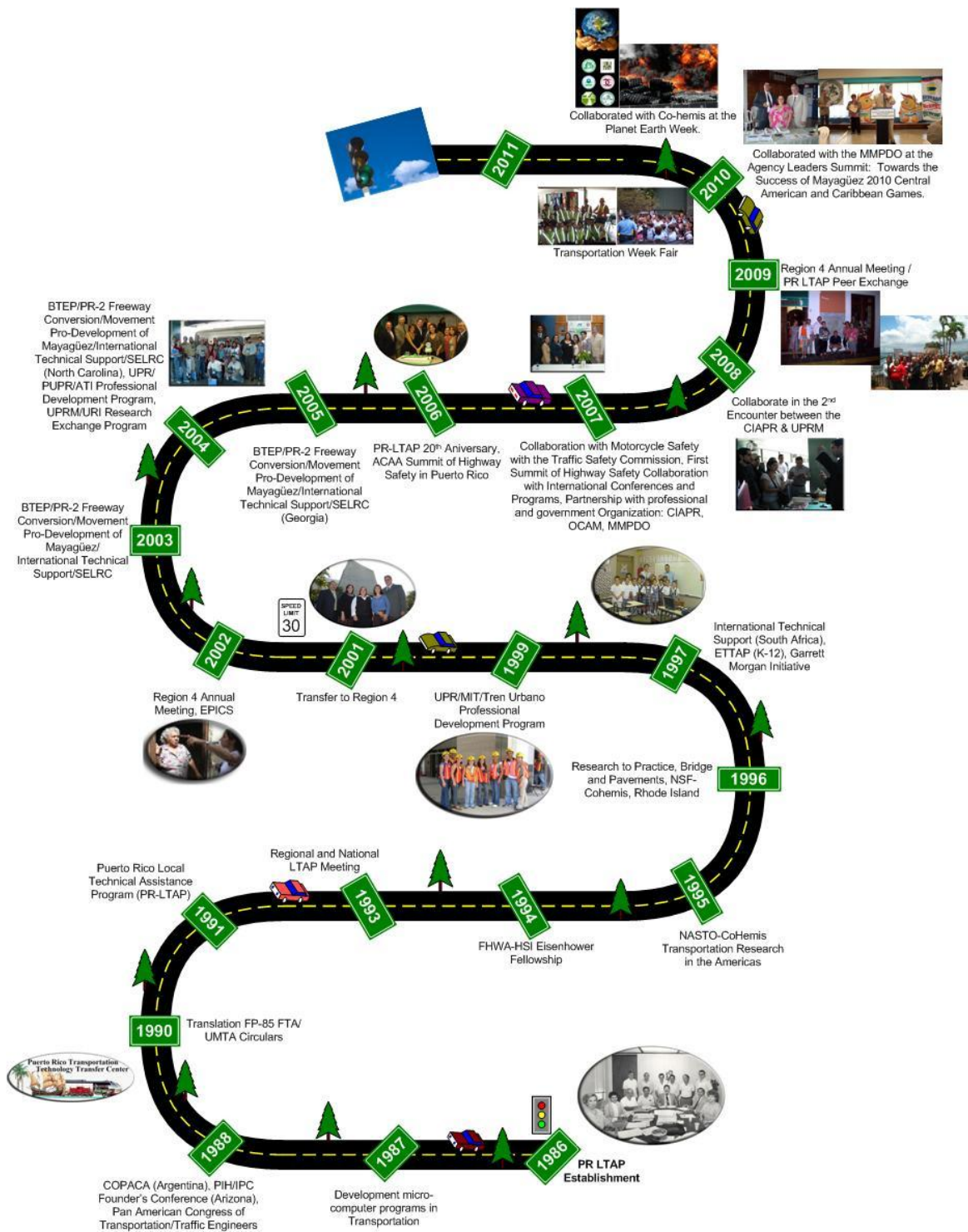


Figure 6: Principal Activities Performed by PR-T²: 1986 – Present (Adapted from Colucci et al. 2007)

#### 4. CONCLUSIONS AND FUTURE CHALLENGES

Engineering education, training, technology transfer and professional development must be based on the emerging needs of our people that are our stakeholders. Those that have the privilege of training engineers play a vital role

in motivating and preparing the emerging workforce to do a job of excellence in addressing the challenges of our Planet and the built infrastructure.

The PR-T<sup>2</sup> Center has played a key role in this aspect during our first 25 years of operation by providing continuing education to undergraduate, graduate students, practicing engineers, transportation and top management officials, bridging with professionals from North, Central, South America and the Caribbean in our mission of sharing and adapting the latest technology in a bilingual setting using the university as the education backbone of the system.

Innovative training and research projects using highly competent engineers working as part of an interdisciplinary team to address emerging local and national engineering infrastructure issues with emphasis on the rehabilitation and sustainability of the built highway network, public transportation, and highway safety to all users will continue to be one of PR-T<sup>2</sup> Center's top priorities, along with increasing the workforce to address these future challenges. The PR-T<sup>2</sup> Center will continue its active role in educating engineers and other transportation-related professionals that serve municipalities and transportation officials with the latest technology to contribute to the knowledge-based in transportation in Puerto Rico, the Caribbean and the hemisphere.

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