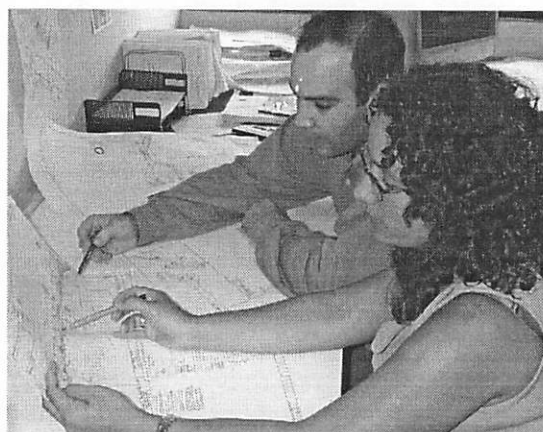
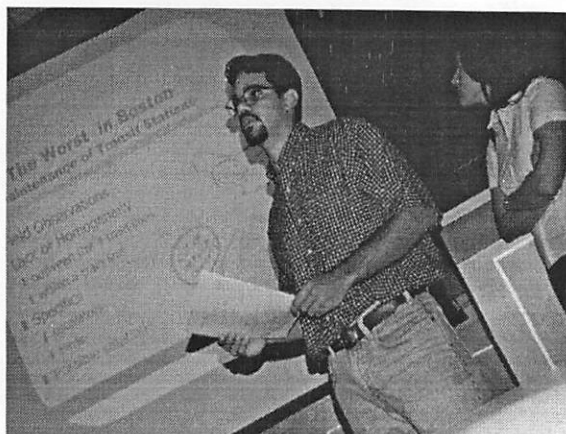
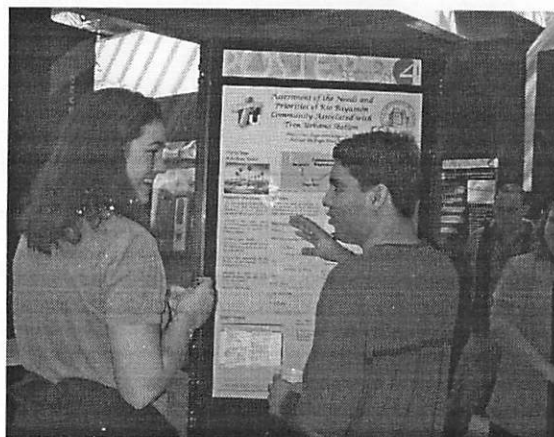
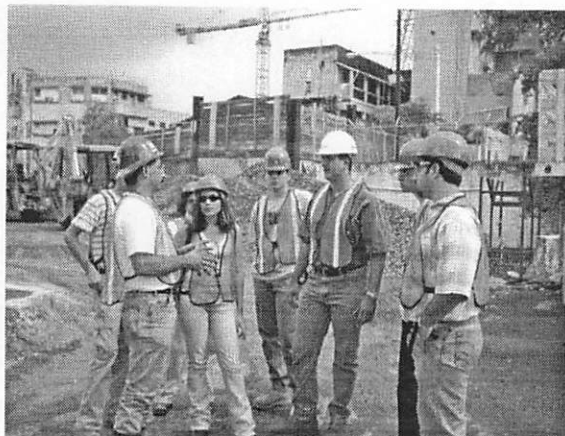


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TREN URBANO TECHNOLOGY TRANSFER PROGRAM

Status Report



Submitted by:

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Benjamín Colucci, University of Puerto Rico at Mayagüez Campus
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Submitted to:

Eng. José M. Izquierdo Encarnación
Secretary, Department of Transportation and Public Works

Dr. José F. Lluch
Executive Director, Puerto Rico Highway Transportation Authority

February 2001

Decisions for Secretary of Transportation & Public Works

- A) Designate new chairperson for Steering Committee.
- B) Make final decision on Spring 2001 trip to Caracas and consider joining the trip.
- C) Decide on continuation of funding as subcontract of GMAEC (to December 2003), so that UPR can admit new students for program (April 2001), MIT can prepare for the June introductory course for new UPR students, and admit new students (September 2001).
- D) Decide on program expansion to include Politécnica, greater UPR planning, urban design, transit marketing, stronger internship and job placement at AMA and Metrobus as well as Siemens.
- E) Decide whether to continue program as component of Minillas extension.
- F) Consider Chicago Transit Authority, Chile, or other international synergy.
- G) Consider visiting MIT, UPR and participating in June short course at MIT.

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Tren Urbano Technology Transfer Program

Project Context

The Tren Urbano Project is a \$1.6 billion, 11-mile, 16-station heavy rail mass transit project expected to begin serving the San Juan Metropolitan Area in 2002. This rail transit project will improve accessibility and mobility of a metropolitan region and develop the next generation of rail transit professionals. The Tren Urbano Project has strategically taken advantage of the environmental, design and construction phase to involve university students in research, professional development and educational activities.

1.0 A brief history and background since 1994

The purpose of technology transfer in Tren Urbano is to develop the next generation of Puerto Rican professionals who will continue the task of championing the cause of quality public transportation for the SJMA during the foreseeable future, and the development of the research and idea base that will continually improve public transportation. The goals of technology transfer are to:

- Develop local expertise in rail transit design, construction and operations;
- Promote research in areas applicable to Tren Urbano and public transportation;
- Provide a living laboratory for the study and research of rail transit technology; and
- Provide a hands-on work experience for students in the program.

Technology transfer has been a key component of the Tren Urbano project since the beginning of the General Management Architectural Engineering Consultant (GMAEC) contract in August 1994. The collaboration between the University of Puerto Rico (UPR), Massachusetts Institute of Technology (MIT) and the Tren Urbano Office (TUO) has been nationally recognized by the Federal Transit Administration (FTA) as a model for integrating university research and students into a transit construction project.

At the UPR the program is currently under the direction of Dr. Benjamín Colucci through the Transportation Technology Transfer Research Center located in Mayagüez. At MIT the program is under the direction of Dr. Nigel Wilson through the Center for Transportation Studies.

In late 1998, a Technology Transfer Steering Committee was established. This group, chaired by a representative of the Secretary of Transportation, is composed of the university coordinators, GMAEC Technology Transfer Manager, GMAEC Program Manager, and Siemens Technology Transfer Manager. The committee meets every two months and reviews upcoming program activities, discusses special opportunities to enrich the program, evaluates program activities, and develops the research agenda in consultation with project staff.

In Technology Transfer, there are two distinct but interrelated programs – the Tren Urbano UPR-MIT Professional Development and Research Program and the Tren Urbano Student Internship Program.

2.0 Tren Urbano UPR-MIT Professional Development and Research Program

2.1 University Tasks

The universities are tasked with student recruitment and selection, supervising student research projects, offering one short course each (June at MIT and January in San Juan), overseeing and coordinating student research projects, conducting weekly student meetings at MIT; at UPR offering seminars on diverse topics including research techniques, report writing, oral presentations; submitting final student research reports to TUO; coordinating a technical site visit to a city with a transit system (UPR); evaluating the program; and submitting an annual progress report to TUO.

2.2 Program Participants

At UPR the students come from three primary disciplines: engineering (civil, electrical, mechanical & industrial), architecture and urban planning. During the past three years, the disciplines have been broadened to include business administration and social sciences. The students are both graduate and undergraduate. At MIT graduate students are recruited from the transportation studies program as well as from urban planning and construction management. In previous years students from geotechnical engineering and seaport planning have also participated in the program. MIT undergraduates participate in a limited way as research assistants to the graduate students under the Undergraduate Research Opportunities Program (UROP). In 1999, MIT expanded university participation to include one professor from Northeastern University and another professor from Boston University. These professors have augmented the range of specialties for students. Also the inclusion of these universities offers a total of three Boston-based universities where UPR graduates might pursue graduate studies.

Another significant program development has been the participation of Highway and Transportation Authority (HTA) engineers. Since 1997, 14 HTA engineers have participated in the UPR-MIT Program. Their participation has greatly enriched the program as well as enhanced the professional development of these young engineers. Typically, these professionals are “traditional: civil engineers who have worked on other highway construction projects. When they are assigned to Tren Urbano as field or office engineers, they normally have limited understanding of public transportation and the Tren Urbano Project as a whole. The summer course at MIT is usually an eye - opener in terms of public transportation, its key role in urban livability, and the Tren Urbano Project as a whole. The interdisciplinary nature of the program also serves to strengthen teamwork and collaboration on the job. Every HTA engineer who has participated in the program has come away with greater enthusiasm and marked

professional growth. The young professionals have contributed greatly by serving as role models for the undergraduate and graduate students.

Since 1994, there have been 210 participants in the UPR-MIT Program as indicated in the table below.

**Tren Urbano UPR-MIT Professional Development Program
Program Participants by University & Gender – 1994-00**

	UPR	MIT	HTA	Other	Total
Male	61	51	10	2	124
Female	49	29	4	4	86
Total	110	80	14	6	210

2.3 Research Component

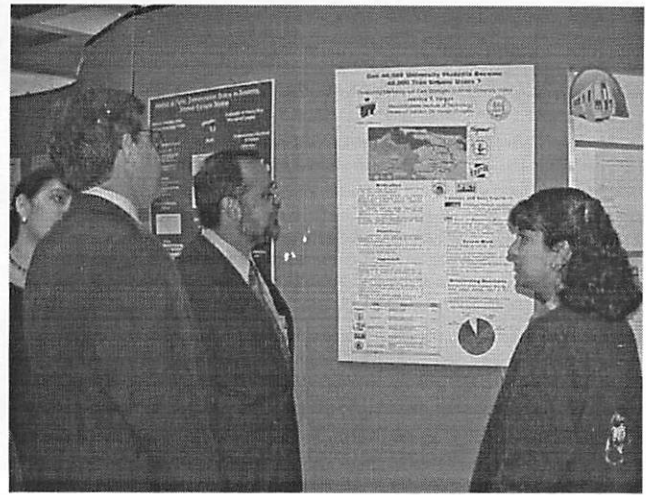
While research is primarily a learning tool for the student, it is also an essential component for establishing a solid knowledge base on public transportation in Puerto Rico. Each student in the program is required to undertake a research For undergraduates, after a period of familiarization, literature search, and consultation with faculty and TU staff, they may collect primary data, analyze and summarize the data, generate new insights and make pertinent recommendations. We have had several outstanding undergraduate research projects. For graduate students, the expectations are higher. They are expected to utilize more advanced analytical techniques and apply more rigorous research methodologies. They may produce primary data, which may advance the state of knowledge in the field. Typically, they will offer practical and constructive recommendations for the project and for further research. Student research is intended to complement and enrich the work of consultants.

When a student selects a research topic, he/she starts by consulting with the faculty advisor and the university program coordinator (Dr. Colucci or Dr. Wilson) to review and discuss areas identified by the Tren Urbano Office. The student may then review projects done by previous students, Tren Urbano Final Environmental Impact Statement, reports and other documents, consult with Tren Urbano / HTA staff. Finally, under the guidance of the faculty advisor, the student shapes the topic into a manageable project, taking into consideration the specific academic degree requirements.

At each university, faculty advisors and the program director closely monitor student research. At UPR students are required to make three (3) presentations throughout the year on their research project. At MIT, students meet on a weekly basis to share information, participate in special presentations and render an account of progress on their projects.

During the January Encuentro, the students prepare posters summarizing their research projects. All posters are exhibited in the TUO atrium and poster sessions are scheduled

to provide an opportunity for receiving input and suggestions from students, faculty and TU project staff.



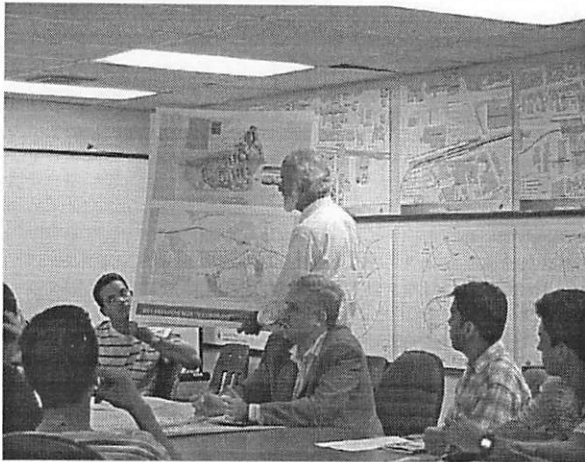
In addition to the presentations the students make as part of the program, they also share their research in such forums as the Transportation Research Board Annual Meeting in Washington, DC, Experimental Project to Stimulate Competitive Research, Congreso de Ingeniería, Agrimensura y Ramas Afines, and others.

The research areas of the past 6 years have included:

- Architecture
- Airport planning
- Buses/públicos
- Construction management
- Controls
- Engineering design
- Environmental
- Fare collection policy & structure
- Finance
- Geotechnical Engineering
- Information Technology
- Intermodal integration
- Joint/economic development
- Land use planning / Zoning
- Marketing/customer information
- Operations
- Procurement & contracts
- Project management
- Rail transit Web-based Trip Planners
- Safety
- Seaport planning
- Social and human behavior
- Traffic engineering
- Transportation planning
- Urban design
- Vehicles

The research component is the primary activity for students in the program and requires the participation of qualified faculty to provide guidance and consultation. This year there are 18 faculty research advisors – 10 from UPR and 8 from MIT, Boston University and Northeastern University. The list of research projects currently under development is included in Attachment I.

2.4 Short Courses



Group 7 UPR students in dialogue with Tren Urbano & HTA staff



Tren Urbano staff in dialogue with MIT students

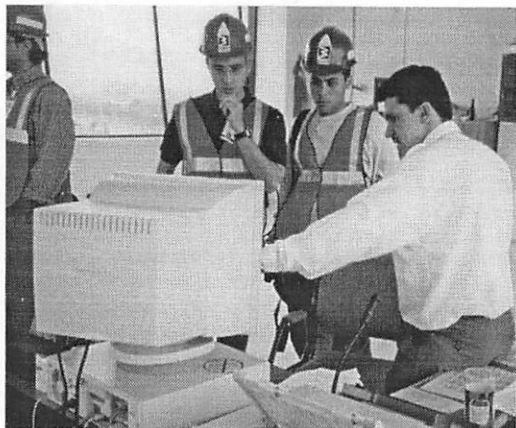
Two short courses on public transportation are offered to the students – one at MIT and another in San Juan. Each is distinct and fulfills a specific purpose. The MIT course introduces public transportation to UPR students in theoretical and practical terms. There are site visits to the facilities of the Massachusetts Bay Transportation Authority (MBTA). Students examine the MBTA system as a case study for excellent and poor practices, which might be applied or avoided in Tren Urbano. MIT students present their final or on-going research projects. The San Juan course, called Encuentro UPR-MIT, focuses on the San Juan metropolitan area, the Tren Urbano project, international public transportation, and highlights student research through the poster exhibit. Each short course also has a sociocultural dimension, which enriches the exchange of information and strengthens interpersonal relations among students and faculty. These two courses are hands-on, multidisciplinary learning events with duration of 6 to 7 days.

2.5 Technical Visits to International Transit System

A vastly enriching, learning experience is the technical visit to an international transit system during spring break. Typically, it's a 3 to 4 day visit that includes an in-depth visit to a rail transit system as well as viewing and learning about associated public transportation systems, intermodal connections and urban improvement projects. The criteria for selection of a system are: 1) a city that is analogous to San Juan in terms of size, 2) a new start system within the previous 10-15 years or less, 3) a culture that is Latin or Hispanic, and 4) availability and willingness of local professionals to share with the group.

During the past years the following cities have been visited: Caracas (1994), Miami (1996), New York, (1997), Medellín (1998, 1999) and Bilbao (2000). The participants have been UPR students and faculty, Spanish-speaking MIT students, and selected MIT faculty, HTA engineers and the TU Technology Transfer Manager. Through the

years a wealth of knowledge, contacts and resources about these systems have been gained. The students are able to advance their research projects with examples of what has worked and what has failed in another system. In 2001, a visit to Caracas and Valencia, Venezuela is proposed.



Students visit Medellín Metro's OCC



Bilbao's FEVE Rail Service

3.0 The Tren Urbano Student Internship Program

The student internship program began in 1995 as a component of the UPR-MIT program with 9 summer student interns. The program was expanded to take advantage of internship opportunities during the academic year after the Systems Test Track Turnkey Contract (STTT) and Alignment Section Contracts (ASC) were awarded in 1996-97. A Tren Urbano internship is not limited to students from UPR or MIT. Local students from various universities have acquired meaningful professional experience as a result of these internships. Over 225 students have participated in internships on the project.

The contractors and GMAEC recruit students from local universities. Internships may last up to 12 months. For some students the internship is part of the Cooperative Education Program at the university. Student interns have become a fundamental part of our project. At GMAEC students assist in expediting, urban design, graphics, project controls, safety, quality assurance, TU web page, administration, and purchasing. Students have also been assigned to TUO (RJA) in auditing, engineering, station art program and permitting.

A special technology transfer opportunity has been developed in conjunction with Siemens to allow students from Puerto Rico to become interns at manufacturing or product development locations in the United States and Europe where significant technological development is occurring. These opportunities were made possible by exercising a contract option through three change orders totaling \$155,000. Twenty-two students have benefited from internships in the United States (Sacramento-12, Atlanta-1, Minneapolis-1, Massachusetts-1, New Jersey-1, and Oregon-1), and in France at MATRA (5 students) where the automatic train control system is being developed. Continued internships at these locations will contribute to ensuring that young Puerto

Rico professionals become thoroughly versed in the technological applications utilized in systems and the vehicles, and will be prepared to participate in operating and maintaining the system. In Attachment III, the statistics regarding the number of interns by company and participants by gender & university are included.



Julio Pérez, Siemens intern, at TS5 vehicle manufacturing plant, Sacramento, CA



Tamara Santiago, intern at the Bayamón Contract Office

4.0 Program Outcomes

Tren Urbano contractors and consultants as well as the HTA have employed students from the UPR-MIT Program who have graduated. In addition to the hired graduates, many students have continued graduate studies in prestigious universities such as MIT, Virginia Tech, Purdue, Georgia Tech and others. The program has significantly advanced academic research in public transportation as applied to Puerto Rico and its unique socioeconomic and cultural context. There is a cadre of young bilingual professionals with expertise in public transportation. These graduates are already applying their public transportation expertise within public agencies in Puerto Rico, and in the public transportation industry.

At the national level, four (4) students have received the American Public Transportation Foundation Hall of Fame Scholarship – 1996, Zaida Rico; 1999, Jessica Vargas (scholarship renewed in 2000); 2000 Jarice Rodríguez and Michelle Laboy. In 1996 it was the first time that a Puerto Rico student was awarded this scholarship.

The most telling outcome of the program is the students themselves, who continually tell us how they have personally and professionally benefited from the program. Providing young professionals an opportunity to work on a major infrastructure project, such as Tren Urbano, is a sure way to develop the next generation of professionals who will provide leadership in the near future. By virtue of the technology transfer program, the Tren Urbano Project will ensure the brainpower and ideas needed to develop a fully integrated public transportation system during the coming generations.

5.0 Future Opportunities

Technology transfer and professional development should be an on-going function during the Minillas Extension, future extensions and operations of the system. As Tren Urbano becomes an operational system, technology transfer will continue to be a priority with Siemens Transit Team.

Some key areas that might be adopted during the next 6 to 12 months are:

1. Expand San Juan presence of urban design students and faculty.
2. Expand marketing faculty and students (Mayagüez).
3. Add participation of Politecnica (San Juan).
4. Add participation of AMA and Metrobus in internships, recruitment, and young professional training.
5. Add technical training in systems and operations & maintenance for selected HTA engineers & managers.

There are special opportunities to shape the research agenda to these phases and the mix of disciplines involved can be adjusted as needed. As the TU project approaches operations, it becomes more evident that HTA will need to develop an in-house capacity to oversee operations, hold the private operator accountable and plan for future extensions. The technology transfer program can be shaped to assist HTA in developing this capacity.

6.0 Publications and papers about Tren Urbano's Technology Transfer Efforts

1. Colucci B., González-Quevedo A., Mercado-Sherman, L., Kruckemeyer, K. and Wilson, N., *Leadership and Professional Development for Public Transportation*, ASCE International Conference on Urban Public Transportation System, Miami, Florida, March 21-25, 1998.
2. Colucci B., Mercado L., *Desarrollo de Líderes y Futuros Profesionales en el Sector del Transporte: Iniciativa Tren Urbano UPR-MIT*, at 19th Congress of Panamerican Union of Engineering Associations (UPADI), Panama City, Panama, August 2000
3. Colucci B., *Un Nuevo Enfoque para el Desarrollo Profesional de los Estudiantes: Iniciativa Tren Urbano UPR/MIT*, Revista Crónicas Universitaria, Año 5, Volumen 1, Octubre 1999, páginas 22-24
4. González-Quevedo, A., Mercado-Sherman, L., Kruckemeyer, K. and Wilson, N., *The Tren Urbano UPR/Professional Development Program* in Journal of Engineering Education, April 2000

Attachment I – On-going Student Research 2000-01
Tren Urbano UPR-MIT Professional Development Program

Student Name	Research Topic	Advisor	University	Program Year
Ardila, Arturo	Organizational Capacity of the Puerto Rico Highway and Transportation Authority to Oversee and Implement Joint Development	Fred Salvucci	MIT	Group 6 - 1999 /Group 7 - 2000
Barker, David	Optimizing the Automated Train Regulation System for Tren Urbano	Nigel Wilson	MIT	Group 7 - 2000
Bernier Rodríguez, Rose	Santurce: Reconceptualizando la ciudad con el Tren	Aníbal Sepúlveda	UPR	Group 7 - 2000
Crockett, Cordy	Analysis of Alternative Service Plans in the Tren Urbano Operations Contract: Maximizing System Benefits Incorporating the Feeder System	Nigel Wilson	MIT	Group 7 - 2000
Dávila Ramos, Daniel	Development of Maintenance Procedures for Tren Urbano Vehicles	Iván Baigés	UPR	Group 7 - 2000
Fournier Rodríguez, Celimar	Evaluation of Strategies to Promote Transit Ridership Among Choice Riders: Application to Tren Urbano	Felipe Luyanda	UPR	Group 7 - 2000
Gamas Buentello, Julia	Economic and Environmental Impacts of Tren Urbano	Bill Anderson	Boston Univ.	Group 6 - 1999 /Group 7 - 2000
Giampaoli, Jorge	Collaborative Negotiation Methodology for Innovative Procured, Multi-Cultural, and Multi-Phase Projects: Tren Urbano - A Case Study	Feniosky Peña Mora	MIT	Group 6 - 1999 /Group 7 - 2000
Jiménez Arocho, Keyla	E-Work: An Architectural Development Directly Liked to Tren Urbano for the Mobile Worker	Esteban L. Sennyey	UPR	Group 7 - 2000
Kavanagh, Alex	Towards an Intermediary Role for IT in Technology Transfer: Tren Urbano	Mike Shiffer	MIT	Group 7 - 2000
Lebrón Durán, Ivelysse	Use of Life Cycle Assessment in the Environmental Decision-Making Process for Transportation Infrastructure Projects	Iván Baigés	UPR	Group 7 - 2000
Lleras, German	Topic to be determined	Ken Kruckemeyer	MIT	Group 7 - 2000
López Pérez, Jorge	Economic Development Model for Jardines Station	Jorge Iván Vélez Arocho	UPR	Group 7 - 2000
Lyn, Sheldon	Evaluation Measures and Strategies for Maximizing the Probability of a Successful in Rail Transit Projects	Fred Salvucci	MIT	Group 6 - 1999 /Group 7 - 2000
Martínez Martínez, Francisco	Análisis de Estrategias Contractuales para Mantener un Nivel de Servicio Eficiente en Sistemas de Rieles	Didier Valdés	UPR	Group 7 - 2000
Moore, Angela	Tren Urbano Disruption Scenarios and Operations Guidelines for Recovery	Nigel Wilson	MIT	Group 7 - 2000
Morales Matos, Yamille	A GPS-Based System for Internet Publishing of Bus Schedules in Real-	Manuel Toledo	UPR	Group 7 - 2000

Student Name	Research Topic	Advisor	University	Program Year
	Time (Joint project with Zharadeen Parrilla)			
Núñez Sierra, Victoria	Plan para la integración del sistema de transportación colectiva a la propuesta Plaza Tren Urbano en Caguas	Aníbal Sepúlveda	UPR	Group 7 - 2000
Park, Ryan	Toward Better Station Access in Pedestrian-Unfriendly Station Environments	Ken Kruckemeyer	MIT	Group 6 - 1999 /Group - 2000
Parrilla Rodríguez, Zharadeen	A GPS-Based System for Internet Publishing of Bus Schedules in Real-Time (Joint project with Yamille Morales)	Manuel Toledo	UPR	Group 7 - 2000
Pérez, Juan	Bus Priority on PR-3	Peter Furth	Northeastern	Group 6 - 1999 /Group 7 - 2000
Ramos Pellicia, Talia	Emergency and Evacuation Systems for Río Piedras Tunnel	Sonia Bartolomei	UPR	Group 7 - 2000
Rivera Martínez, Jodselyn	Potential Impact on Land Use Along the Tren Urbano Alignment	Jaime Gutierrez	UPR	Group 7 - 2000
Rodríguez, Pilar	Improving Transit Access from Caguas to Tren Urbano	Nigel Wilson / Ken Kruckemeyer	MIT	Group 7 - 2000
Rodríguez Ramón, Angel	Diseño de la Frontera Caribeña Estación del TU para el AILMM	Esteban Sennyey	UPR	Group 7 - 2000
Román Torreguitart, Jaime	Feasibility Study of Implementing a Web-Based Information System for Tren Urbano	Benjamín Colucci	UPR	Group 7 - 2000
Rullán Bidot, Sara	The Application of Total Productive Maintenance to the Storage and Maintenance Facilities of Tren Urbano	Sonia Bartolomei	UPR	Group 7 - 2000
Santos Cotto, Obed	Development of Maintenance Procedures for Tren Urbano Vehicles	Iván Baigés	UPR	Group 7 - 2000
Santos Hernández, Michael	Web-Based Trip Planner for Tren Urbano	Benjamín Colucci	UPR	Group 7 - 2000
Switzky, Joshua	From Insular Enclaves to Integrated Transit-Oriented Communities: Design Guidelines and Zoning Controls for Tren Urbano Station Areas	Ken Kruckemeyer	MIT	Group 7 - 2000
Tilgner, Melanie	Bus Signal Priority and Operational Control in the Viejo San Juan Corridor	Peter Furth	Northeastern	Group 7 - 2000
Torres Reyes, Cristina	Issues Related to the Implementation of HOT Lanes as Feeders for Tren Urbano Plazas	Didier Valdés	UPR	Group 6 - 1999 /Group 7 - 2000
Vargas González, Jessica	"Unlimited Access" for the university population of the SJMA: An innovative program for Tren Urbano and universities	Joe Coughlin	MIT	Group 5 - 1998 /Group 6 - 1999 /Group 7- 2000

Attachment II - Tren Urbano Internship Program 1995-01

Interns by Companies

Companies	Number of Interns
GMAEC	87
Siemens	71
ICA/Miramar	13
KKZ	25
Redondo	16
Necso	15
Soletanche	1
Total	228

Student Interns by University & Gender 95-00

	UPR	MIT	Politécnica	Inter. Univ.	Other	Total
Male	73	6	54	4	6	144
Female	49	6	22	2	5	84
Total	122	12	76	6	11	228

Interns by Status 1995-01

Current Intern	21
Studying	82
Hired	95
Status Unknown	30
Total	228