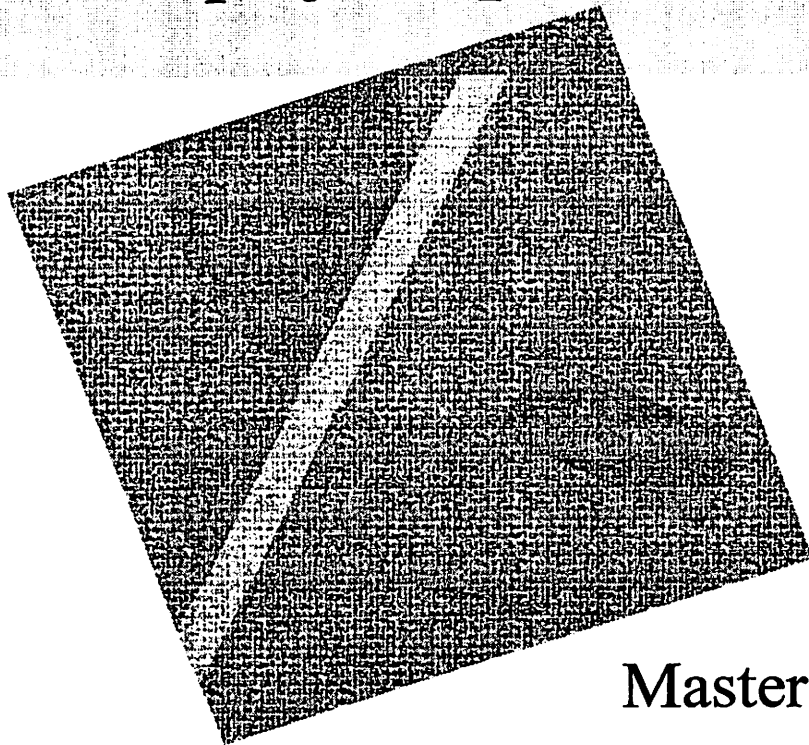


Plan for the Physical and Socioeconomic Rehabilitation of Suburban Sectors in Decay in the Vicinity of the Río Hondo Expressway and the Complejo Deportivo Tren Urbano Station

Progress Report



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January 1999

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Justification

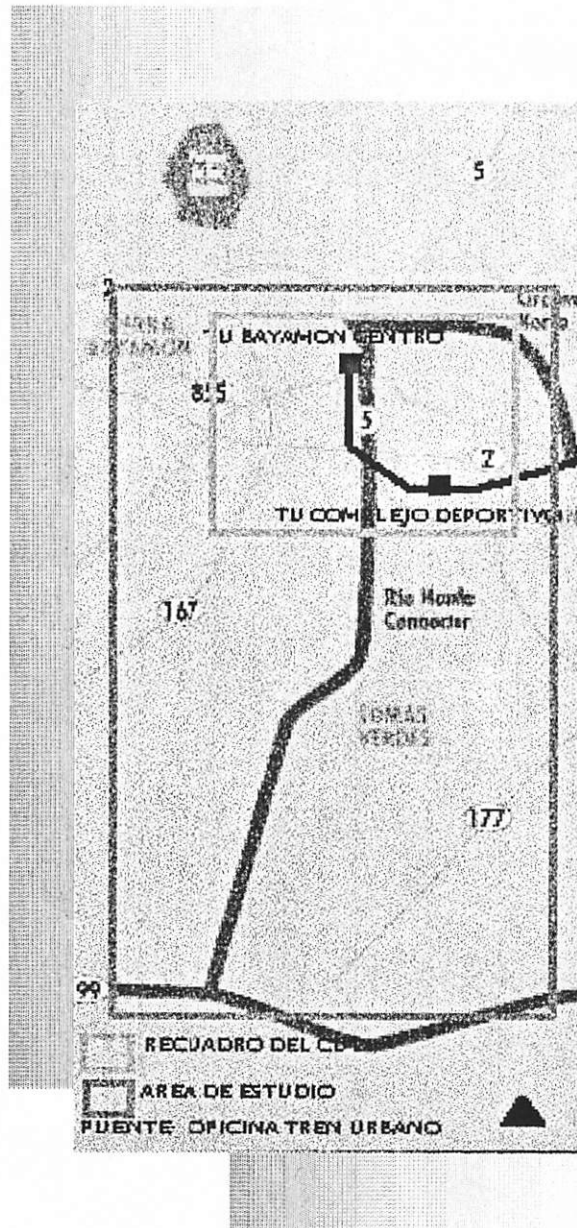
- Recent acknowledgment of physical and socioeconomic decay as a suburban problem.
- Application of New Urbanism Theories to the suburban problem's analysis and resolution.
- One of the first applications of New Urbanism Theories to the Puerto Rican suburban reality.

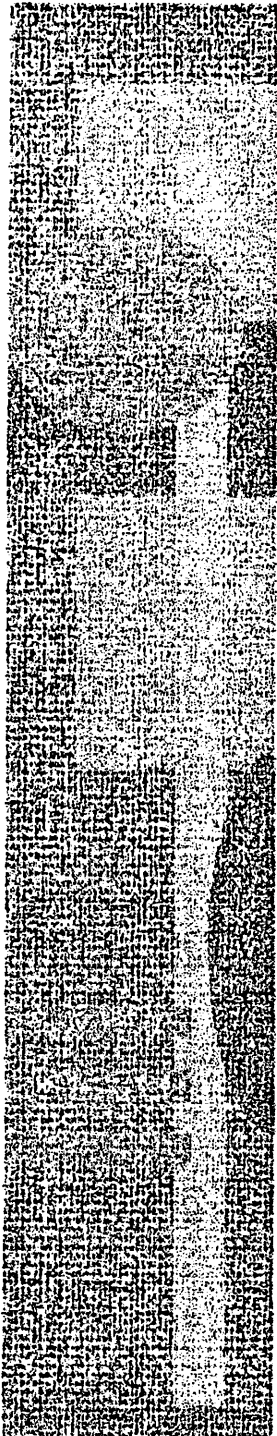
Introduction

- Suburban decay has become a relevant problem for the Municipality of Bayamón.
- The construction of the Río Hondo Expressway and the Complejo Deportivo Tren Urbano station provides an opportunity for rehabilitation.
- Location, Trip Generation, and New Urbanism theories provide a framework upon which to base intervention alternatives.
- Alternatives must foster job and housing density, diversity, economic self-sufficiency, regional mobility, local accesibility, and adequate land use combination.
- Current local and central urban policy and economic development strategies do not foster this objectives.
- Proposed policy and strategies incorporate federal homeownership and suburban rehabilitation initiatives, as well as community and entrepreneurial leadership as potential private investors.

PROBLEM

Suburban Decay in the Vicinity of the Río Hondo Expressway and the Complejo Deportivo Tren Urbano Station





Suburban Decay in the Vicinity of the Río Hondo Expressway and the Complejo Deportivo Tren Urbano Station

- Suburban Migration results in urban sprawl
- Development along nodules and axes grow until melting with other cities'
- Empty urban centers due to changes in land uses, life styles, travel patterns, employment structure, and population needs.
- Exerts pressure over deficient infrastructure systems
- Abandoned commercial, industrial, and residential buildings and undesirable, non-complementary land uses along primary roads discourage private investment
- Calls for higher housing density and an adequate land use combination

Intervention Opportunity

- Investment on Civil Infrastructure for the study site
 - Complejo Deportivo Tren Urbano Station
 - Río Hondo Expressway (PR-5)
 - Incorporates HOV lanes
 - Offers access from the study site to the TU station
 - Links público and AMA users from the area and other municipalities to public transportation terminals
- Increases propensity to suburban decay
- Nonetheless, provides opportunity to halt urban sprawl and rehabilitate these communities re-organizing their development

Conceptual Framework

Location Theory

- Household location is determined by:
 - socioeconomic preferences
 - limited budget for consumption goods, land, and transportation.
- Ceteris paribus, the consumer must distribute income between housing and transportation expenses.
- The marginal cost of residential land is inversely proportional to the distance from activity nodes.
- Travel time is an important element of transportation cost.
- Accessibility to mass transit is directly proportional to affordability of more expensive housing units in urban centers and nearby suburbs.

Conceptual Framework

Transit Generation

- The utility derived from a location is inversely proportional to the level of traffic congestion to which the household members are subjected.
- Urban land use equilibrium models determine housing and job location simultaneously.
- Urban space generating agents are responsible for development clusters subjected to traffic congestion.

Conceptual Framework New Urbanism and Transit Oriented Development (TOD)

- The success of any New Urbanism project depends on achieving an adequate balance among strategic investment, regulation and public policy, fiscal incentives, market availability, location, design, and capital readiness.
- Balanced communities are self-contained and self-sufficient maintaining equilibrium between housing supply and job availability.
 - Depends on zoning, housing costs, and changes in demographic trends.
 - Must increase regional mobility and local accessibility to mass transit fostering higher unit and population densities at a pedestrian scale.
 - Must foster socioeconomic and architectural diversity.

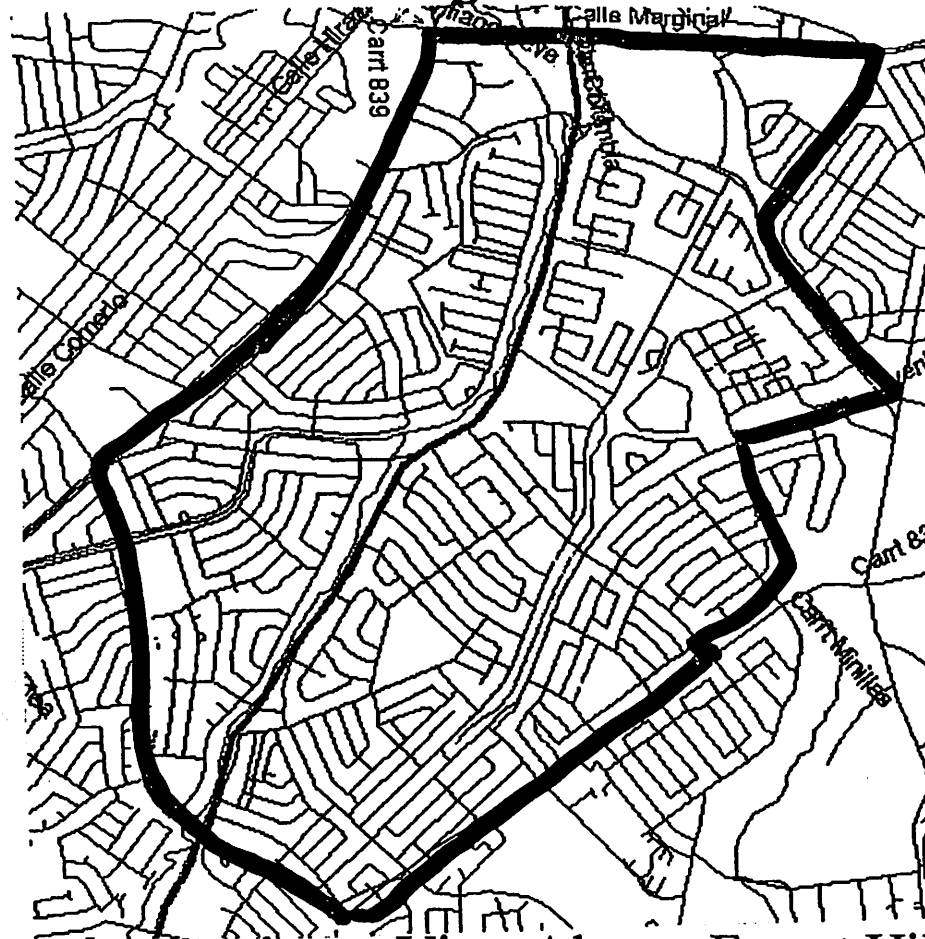
Objectives & Goals

- Revert population movements applying New Urbanism Theories to suburban rehabilitation and community revitalization
- Foster a compact, and competitive city through an integrated, intermodal mass transit system
- Establish a causal relationship among socioeconomic profiles, development patterns, civil infrastructure supply, public policy, and suburban decay.
- Revise current public policy and development strategies
- Re-organize development through land use re-distribution and increased accessibility provided by an efficient, integrated transportation system

Methodology

- Historic Background - MB & PR archives
- Spatial growth - orthophotographic study
- Socioeconomic household profile - US Census of Population
- Analysis of current laws, regulation, public policy, and plans - MB, JP, ACT, DTOP, USDHUD, USDOT
- Analysis of current economic development strategies - MB
- Scheduled projects and strategic investment
- Land use inventory
- Functional Population Analysis - DTRH
- Traffic generation gravitational model
- Scenario design

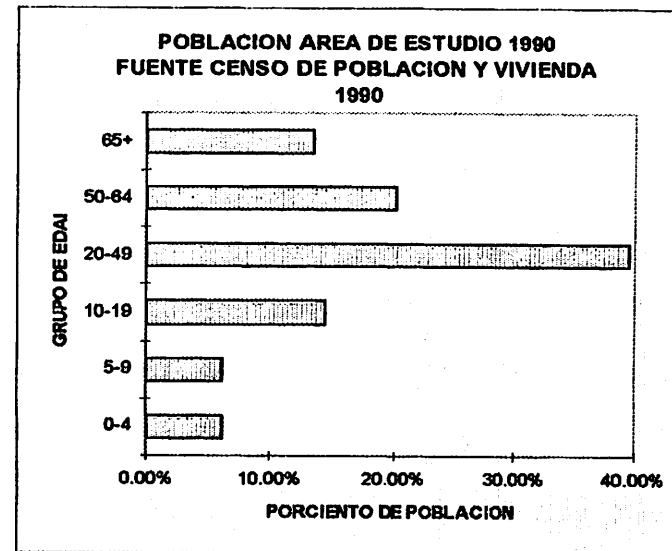
Study Site



- Includes nine urbanizations: Vista Alegre, Forest Hills, Villa Contesa, Francisco Oller, Forest View, Santa Juanita, Lomas Verdes, Flamboyán Gardens, and Alturas de Flamboyán.

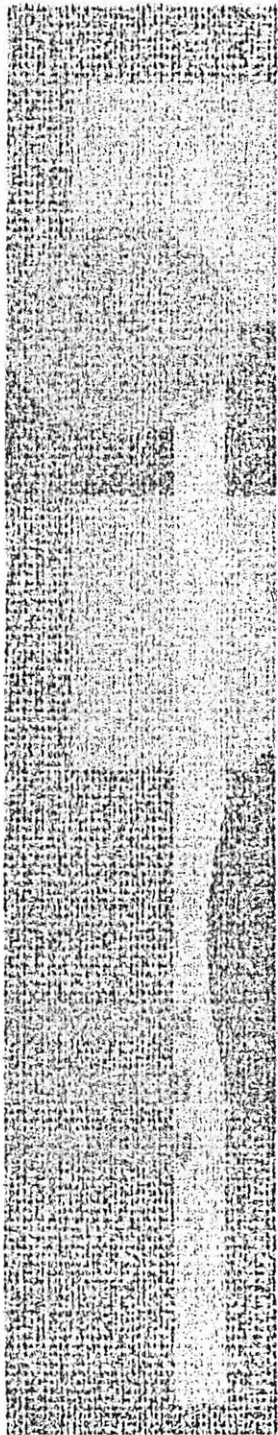
Socioeconomic Profile

EDAD	POBLACION	
0-4	6.21%	1,472
5-9	6.17%	1,464
10-19	14.37%	3,408
20-49	39.61%	9,392
50-64	20.21%	4,793
65+	13.42%	3,183
TOTAL	100.00%	23,712



- The area includes 26 census block groups.
- Population 23,712 (10.77% of Bayamón's total)
- Families 6,483 (11.32%)
- Households 7,828 (11.90%)
- Average household income \$13,725 (7% above Bayamón's)
- Owner occupied housing units 73.3%; renter occupied 26.7%

This image shows a vertical strip of a book's endpaper. The paper has a light, textured background with a repeating pattern of small, dark, rectangular marks, possibly a decorative border or a section of the book's binding. The pattern is consistent throughout the strip.



This image shows a vertical strip of a book's endpaper. The paper has a light, textured background with a repeating pattern of small, dark, rectangular marks, possibly a decorative border or a section of the book's binding. The pattern is consistent throughout the strip.

Current Municipal Urban Policy

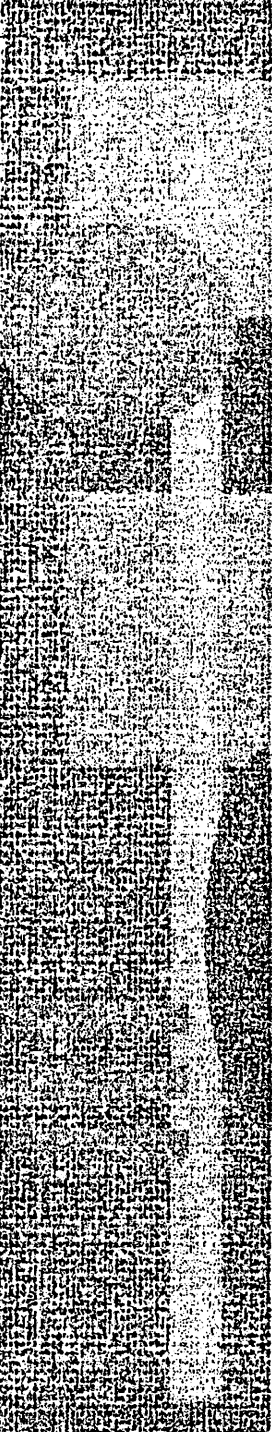
- Strengthen the socioeconomic and physical structure of local communities.
- Revitalize public spaces and preserve green areas.
- Develop a multimodal mass transit system.
- Increase density fostering an adequate land use combination.
- Residential revitalization through increased job and housing density
- Improve civil infrastructure, not water or electric power
- Decentralization through community involvement

Current Central Government's Urban Policy

- Complete SJMA strategic road network (\$400M investment over 4 yrs) to minimize congestion and support an integrated multimodal system of trains, buses, and públicos.
- Río Hondo Expressway with HOV lanes
- NO projected suburban AMA routes
 - current E92, E93
 - The success of the Complejo Deportivo TU station depends on the integration of community based suburban bus routes to the train system

Current Federal Urban Policy

- Incorporates New Urbanism theories
 - land use re-organization
 - suburban rehabilitation
- Foster private investment in mixed partnerships for recycling lost spaces.
- Economic structure based on small businesses and community entrepreneurship.
- Affordable homeownership opportunities for low and moderate income households.
- Against social segregation
- Fosters socioeconomic and architectural diversity
- Recognizes importance of higher density housing in increasing accessibility to mass transit



Current Municipal Development Strategy

- Economic structure based on supraregional commercial centers
- Negative impact over territory morphology and urban center's economic activity.
- Conversion of residential land use to non-complementary uses along primary roads.
 - results in regional mobility and local accessibility problems
 - negative impact over small local businesses

Proposed Economic Development Strategies

- Economic development as problem solving.
- Economic development as running a business.
 - Government as entrepreneur.
 - Maximize capital.
- Increase exports; diminish dependence on imports and exterior assistance
 - Strike for self-sufficiency
- Foster the creation of community corporations and small local businesses.
- Rehabilitation as instrument for increases in land value and quality, regional mobility, and local accessibility.
- Joint investment: public and private, entrepreneurial and community based.
- Fiscal incentives for local investors.

Proposed Urban Policy: Objectives

- Improve suburban quality of life;
- Increase local accessibility;
- Minimize travel times;
- Rehabilitate the physical environment;
- Revitalize the economy;
- Foster social justice;
- Attain socioeconomic self-sufficiency;
- Foster citizen activism;
- Encourage entrepreneurial leadership;
- Encourage the use of an intermodal mass transit system;
- Foster physical and socioeconomic diversity in the city.

New Urban Policies

- Rescue, recycle, rehabilitate lost spaces and abandoned structures through private investment in low cost housing and small local businesses.
- Increase housing density by adding second and third floors.
- Offer incentives to small businesses.
- Foster land use, architectural, and socioeconomic diverse communities.
- Improve water and electric power infrastructure.
- Offer assistance for the creation of community corporations, i.e.. for transportation and rehabilitation.
- Offer incentives for the use of HOV lanes.
- Attract employment centers to balance out job-housing ratio

Conclusion

- Suburban communities in the vicinity of PR-5 are sociospatial units.
- As such, proposed alternatives must respect their social and cultural values as well as the residents' sense of belonging.
- A satisfactory community contains a well balanced land use combination.
- Proposed alternative: physical and socioeconomic rehabilitation *a la* New Urbanism.
 - Maximizes capital, particularly human capital.
 - Constitutes an income redistribution and social justice instrument.
 - Fosters increases in job availability.
 - Minimizes imports and dependence on external aids.
 - Fosters community and entrepreneurial leadership.
- The sector must seek status of self-governed political settlement.

Future Research

- Detailed US Census of Population and Housing chronological data analysis
- Land use inventory
- Resident preference survey
- Detailed functional population analysis
- Trip generation model and analysis
- Scenario design and analysis
- Analysis of alternatives
- Project proposal: implementation plan

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Acknowledgments

- UPR Graduate School of Planning
 - Faculty
 - Library
 - Computer Lab
- Municipality of Bayamón
 - Planning Office
- PR Planning Board
- Tren Urbano
- MIT Department of Civil Engineering
 - Center for Transportation Studies



Anti-Slide Break Control System for Tren Urbano



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Objectives of the Research



- Application of anti-slip/slide break technology using Slip Velocity Feedback Torque Control to the TU trains
 - Minimize and regulate the slip velocity and slip response
 - Learn how to design an anti slip/slide controller using the dynamic system simulator SIMULINK

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Background Information

- Dynamic model of the system from the principles of physics and the parameters of the Tren Urbano cars
- Design a controller for optimum performance using SIMULINK
 - The Root Locus Method and the Nyquist Stability Criterion are used to design the controllers and evaluate its performance

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Work Performed

- Recompilation of information about different control systems for anti-slip/slide in trains and the methods to minimize the slip
- Study of the different characteristics and events that can cause the slip in the wheels of the trains
- Perform simulations with the system of control known as Slip Velocity Feedback Torque Control using common parameters for the train systems
- Study of the stability, utility and benefits for anti-slide brake systems of trains with different kind of motors

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Terminology

- Traction coefficient between wheel and rail is the traction effort divided by wheel axle weight
- Adhesion – the ability of the wheel to exert the maximum traction force on the rail and still maintain persistence of contact without sliding. Adhesion can be given by the formula given in equation:
 - $F_a = \mu N$

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Terminology (cont.)

- Where:
 - F_a is the force of adhesion
 - μ is a factor known as the coefficient of adhesion
 - N is the normal force at the point of contact of the rail and the wheel
- Slip velocity - is the difference between the vehicle velocity and the wheel velocity with respect to the wheel velocity

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Coefficient of Traction

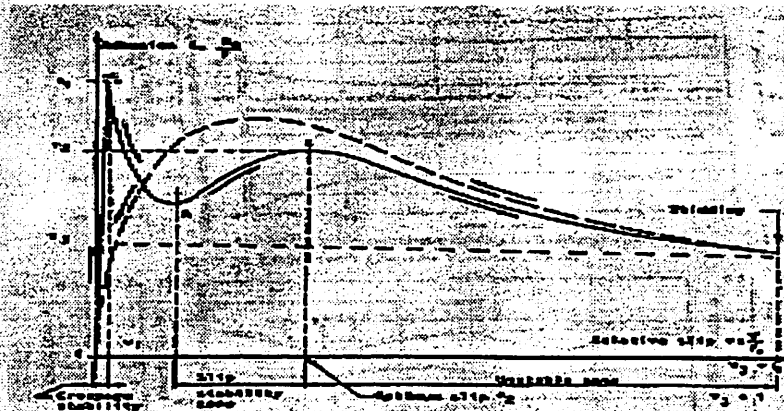


Fig. 1 Coefficient of Traction described in ORE report

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Problems with the Slip

- Affects the passengers confort specially under bad wheel-rail conditions
- Affects the acceleration of the wheel, the braking distance and the adhesion beetwen the wheels and the rails
- Affects the speed of the trains and the coefficient of traction
- Affects armature current, the traction effort and the output torque
- Affects the life of the traction motors and increases the rotational losses

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Why reduce the slip velocity?



■ If the slip velocity is reduced

- we can get more control of the vehicle when the vehicle brake
- the wheel slip/slide condition affects less the torque of the motor
- the readhesion in the wheels will increase and the passenger will feel less the acceleration when the vehicle brake
- and if the slip velocity is reduced to an optimal value we will get the maximum adhesion force

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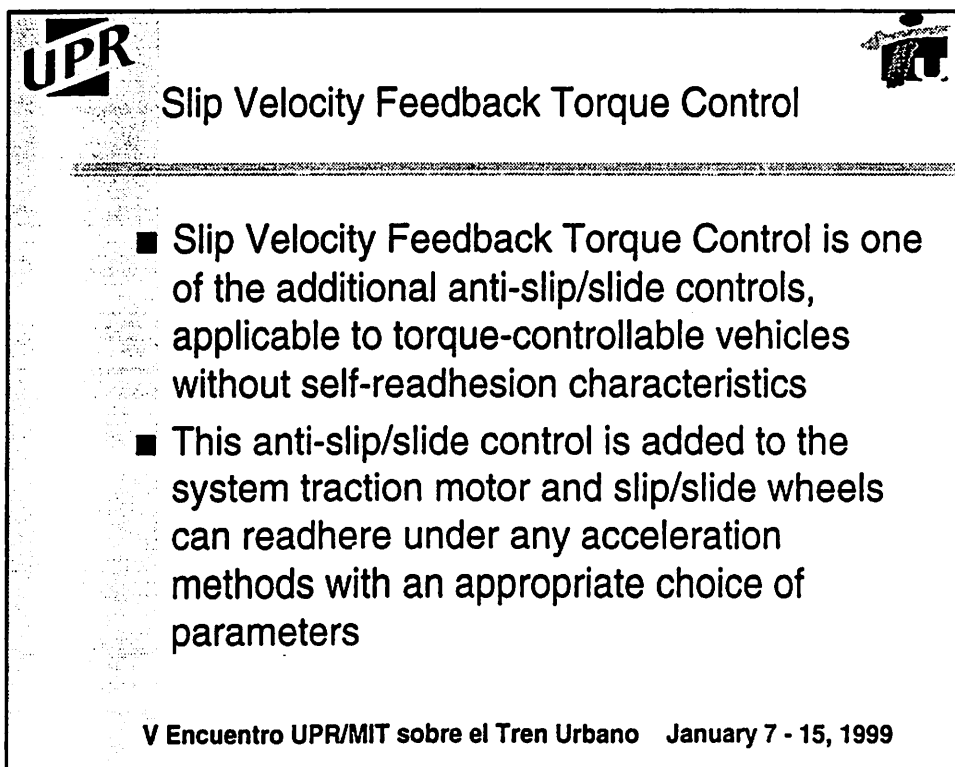
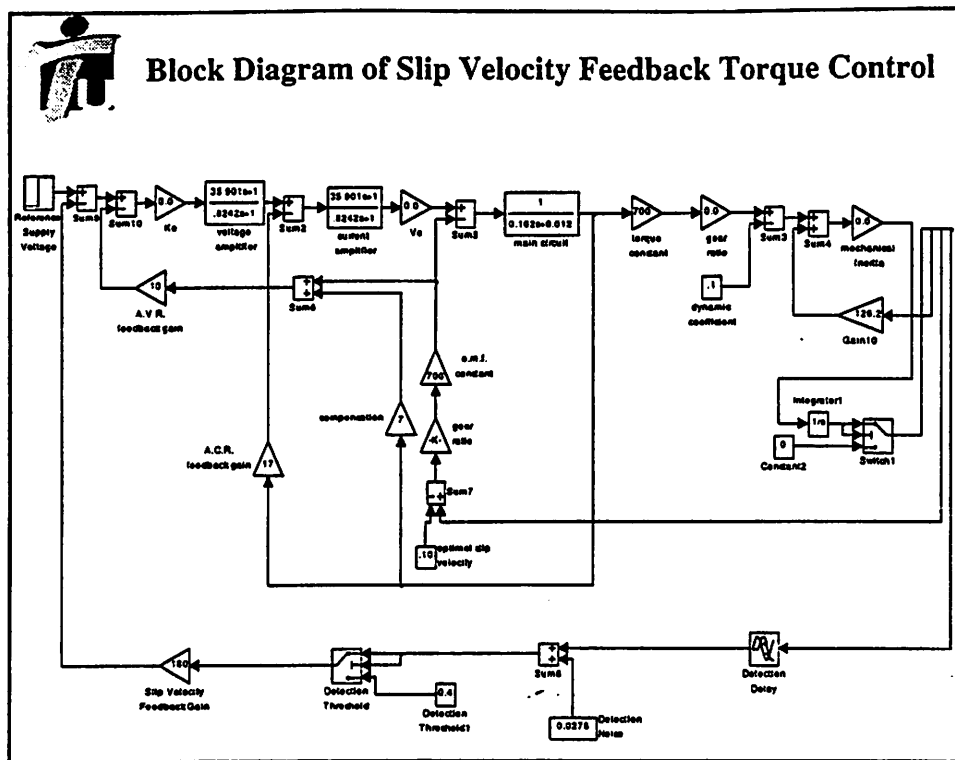
But, why do not eliminate the slip velocity?



■ If the slip velocity is eliminated:

- the traction coefficient will be zero
- we will have serious problems in the readhesion characteristics of the vehicle
- physically is impossible eliminate the slip velocity

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Slip Velocity Feedback Torque Control (cont.)



- The merits of "Slip Velocity Feedback Torque Control" are:
 - With an appropriate choice of 2 parameters (slip/slide velocity feedback loop gain K , and electric time constant τ_e), wheels can readhere under any slip/slide conditions
 - The control doesn't produce a peak current and output torque varies smoothly, consequently giving a more comfortable ride
 - Detection of small slip/slide minimizes torque reduction required for readhesion

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Slip Velocity Feedback Torque Control (cont.)



- Equation for torque on the driving axle:
 - $T + \tau_e dT/dt = T_0 - K V_s$
- The dynamic friction coefficient between wheel and rail varies in accordance with the following formula:
 - $\mu_v = \mu_s - \Delta \mu - \rho V_s$
- The Slip equation:
 - $\tau_m \tau_e d^2 V_s / dt^2 + (\tau_m - \tau_e) dV_s / dt + (K r \tau_m - J) V_s / J = \Delta \mu / \rho$
 - $\tau_m = J / (\rho g W r^2)$

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Slip Velocity Feedback Torque Control (cont.)



■ where:

- μ_v : coefficient of traction between wheel and rail
- μ_s : adhesive coefficient
- V_s : slip velocity driving axle
- T_0 : initial value of the torque imposed on the driving axle
- g : acceleration of gravity force

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Slip Velocity Feedback Torque Control (cont.)



- W : axle load mass
- r : wheel diameter
- J : synthesized moment of inertia converted around the driving axle
- ρ : gradient of dynamic friction coefficient to slip velocity

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Effects of the Elements on Slip/Slide Velocity Detection



- Effect of slip/slide velocity detection delay (dead time)
 - Detection delay makes the maximum slip velocity greater and the coefficient of traction widely variable when the slip/slide wheels adhere
- Effect of threshold level slip/slide velocity detection
 - The lower the threshold level becomes without noise and delay, and the larger the slip velocity feedback gain becomes under the same threshold level, the better will be the re-adhesion characteristics

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Effects of the Elements on Slip/Slide Velocity Detection (cont.)

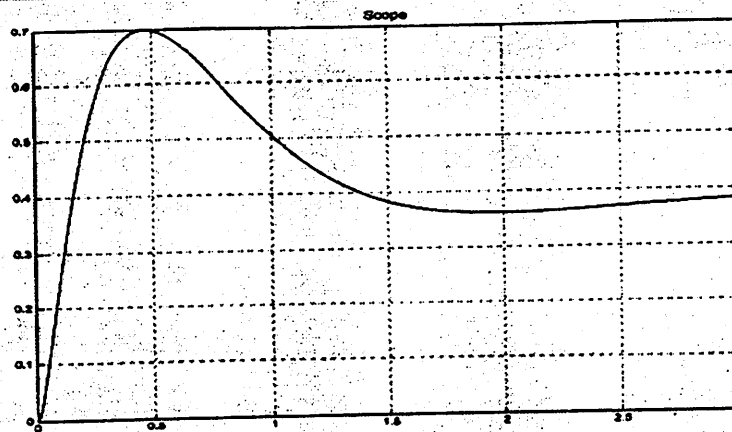


- Effect of slip/slide velocity detection noise
 - The effect of the noise is from the view point of torque restoration after readhesion, coefficient of traction goes down and traction effort constantly fluctuates. If the detection threshold goes up, the effect of noise can be eliminated
- Effect of detection error
 - The smaller the detection error, the better become the readhesion characteristics

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Response of the System with a Disturb



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Analysis of Results



- With the use of Slip Velocity Feedback Torque Control, the slip velocity can be maintain in an optimal value that can help the traction effort. We recommend for TU trains a threshold of 0.4 km/hr
- If the wheel slip occur under a low adhesion coefficient, this has the effect of reducing the force transferred as traction effort
- The traction effort will decrease when the velocity of the train increses, but when the velocity reaches a specific value, the traction effort will become stable

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Preliminary Conclusions



- The Slip Velocity Feedback Torque Control can be applicable to any torque-controllable vehicles in any state of control, under the consideration of plant dynamics
- Detection delay greatly affects the readhesion characteristics
- This control system is required in Puerto Rico due to its tropical weather. The rain causes the wheels of the train to slip when braking or running.

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Future Work



- Use more parameters for Tren Urbano necessary to perform a simulation for the study of the stability of the system
- Redesign of the block diagram, optimizing with PID compensators for a best stability, settling time and percent overshoot near to zero
- Study of specific control circuits and other methods to develop an antislip/slide system
- Study other methods to reduced the slip velocity and compare with the Slip Velocity Feedback Torque Control

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Geotechnical Conditions Along Future Extensions of the Tren Urbano System

Carolina Extension

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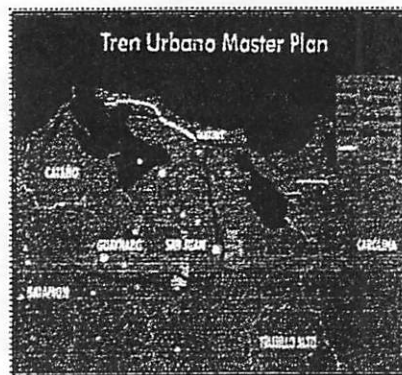


Review

- ◆ An attempt will be made to establish a soil profile along the extension of the Tren Urbano proposed for Carolina.
- ◆ The profile will be used to establish potential problems that could be found during construction due to geotechnical conditions in the area.
- ◆ The resources to be used are:
 - * Geological maps
 - * Aerial photos
 - * Topographical maps
 - * Geotechnical reports
 - P.R.H.T.A.
 - Private entities

Introduction

- ◆ The total system of the Tren Urbano will consist of 6 alignments.
- ◆ One of these alignments, the Carolina extension, will consist of 9 stations and have a total length of approximately 13 km.
- ◆ The geotechnical conditions that exist along Carolina extension will be studied.

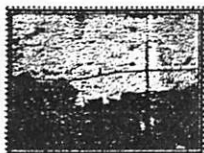


Objectives

- ◆ Study the geology of the area of Carolina.
- ◆ An attempt will be made to establish a soil profile along the alignment proposed for Carolina.
- ◆ Establish potential problems that can be found during construction due to the geotechnical conditions.

Resources

◆ Geological maps



◆ Aerial photos



◆ Geotechnical reports

- PRHTA
- Private entities

Station	Soil Type	Depth (m)	Unit Weight (kN/m³)	Compressive Strength (kN/m²)	Shear Strength (kN/m²)	Angle of Friction (°)	Cohesion (kN/m²)
1	CL	0-1.5	18	100	10	25	10
2	CL	1.5-3.0	18	100	10	25	10
3	CL	3.0-4.5	18	100	10	25	10
4	CL	4.5-6.0	18	100	10	25	10
5	CL	6.0-7.5	18	100	10	25	10
6	CL	7.5-9.0	18	100	10	25	10
7	CL	9.0-10.5	18	100	10	25	10
8	CL	10.5-12.0	18	100	10	25	10
9	CL	12.0-13.5	18	100	10	25	10
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11	CL	15.0-16.5	18	100	10	25	10
12	CL	16.5-18.0	18	100	10	25	10
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15	CL	21.0-22.5	18	100	10	25	10
16	CL	22.5-24.0	18	100	10	25	10
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63	CL	93.0-94.5	18	100	10	25	10
64	CL	94.5-96.0	18	100	10	25	10
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83	CL	123.0-124.5	18	100	10	25	10
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86	CL	127.5-129.0	18	100	10	25	10
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97	CL	144.0-145.5	18	100	10	25	10
98	CL	145.5-147.0	18	100	10	25	10
99	CL	147.0-148.5	18	100	10	25	10
100	CL	148.5-150.0	18	100	10	25	10

Geological Maps

◆ Formations

- * **Kf (Frailes formation)** = volcanic sandstone and volcanic breccia (700m - 800m)
- * **QTt (older alluvial deposits)** = sandy clay containing a few pebbles of volcanic rock (< 10m)
- * **Tr (Rio Piedras siltstone)** = siltstone and fine grained sandstone and local layers of crumbly clay.

Geological Maps

- * **Tc (Cibao formation)** =limestone interbedded with sandy clay and claystone (35 m)
- * **Tg (guaracanal formation)** = coarse breccia generally weathered to clayey sand (0-270 m)
- * **Af (Artificial fill)** = material from various sources hauled in swampy places to provide foundations for housing

Aerial Photos

- ◆ **Identify places where geotechnical data is available.**
 - * **PRHTA**
 - P.R. 181 over P.R.3
 - Intersection P.R. 8860 with P.R.887
 - Intersection of Ave. Monserrate with the P.R.874
 - Along the proposed route 66

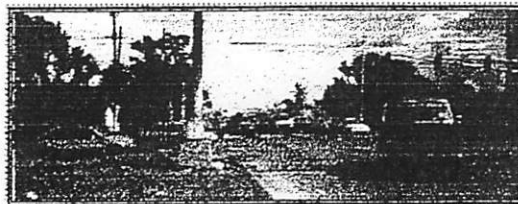
Aerial Photos

- Intersection of P.R. 8 with P.R.3
- Bridge over P.R.853
- Teodoro Moscoso bridge
- Tren Urbano station in Rio Piedras
- * Private entities
 - Plaza Escorial project
 - Plaza Carolina project (parking garage)
 - Santiago Corp. (Theaters)

Geotechnical Reports

◆ Available studies

1. Overpass bridge at P.R.181 over P.R.3
 - made by Despiau Associates Corp
(December 1994)



Geotechnical Reports

2. Intersection P.R.8860 with P.R. 887

- made by Geocom Engineering (march 1996)



Geotechnical Reports

3. Intersection of Ave. Monserrate with the P.R.874

- made by Jaca & Sierra Testing Laboratories (march 1990)

4. Proposed P.R.66

- made by Soil Tech (June 1997)

Geotechnical Reports

◆ Typical information in a geotechnical report.

* Laboratory Testing

- Identification and Classification of the soil
- Moisture content
- Atterberg limits
- Unconfined Compressive Strengths (q_u)

* In-site Testing

- Standard Penetration Test

Laboratory Testing

◆ Identification and classification of the soil

- * visual - manual procedure
- * Grain size distribution test

◆ Moisture contents

- * It is expressed in percentage of the given ratio of the weight of the water and a given soil mass to the dry solid particles in it.

Laboratory Testing

◆ Atterberg limits

* Describe the consistency of fine grained soils expressed as water content.

- Shrinkage limit → transition from solid to semisolid
- Plastic limit → transition from semisolid to plastic
- Liquid limit → transition from plastic to liquid

Laboratory Testing

◆ Unconfined compressive strengths (q_u)

* Is a measure of the shear strength of a soil.

¹ Table 1: Relationship between Consistency and q_u

Consistency	q_u (ton/ft ²)
Very soft	0 - 0.25
Soft	0.25 - 0.5
Medium	0.5 - 1
Stiff	1 - 2
Very stiff	2 - 4
Hard	> 4

In - Site Testing

◆ Standard penetration test (SPT)

- * The test consists of driving a sampler of standard dimensions in a boring hole.
- * Driving of the sampler is accomplished using the drop of hammer of 140 pounds from a height of 30 inches.
- * The number of blows for three consecutive six inches of penetration of the sampler are recorded.

In - Site Testing

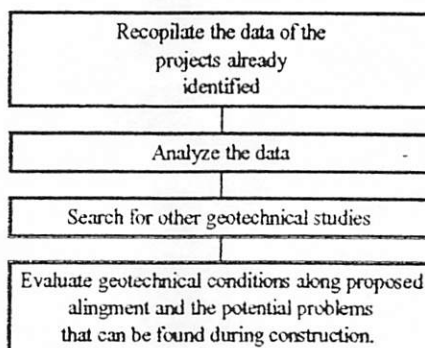
- * The number of blows for the last foot of penetration is reported as the N value.
- * The N value is an index of the soil behavior.
- * Correlation between the N value and engineering properties.
 - Shear strength
 - Relative density
 - Compressibility

Information in a Boring Log

- ◆ Depth of boring
- ◆ N value
- ◆ Moisture content
- ◆ Unconfined compressive strength
- ◆ Soil description

Boring Log									
Boring No. 1					Boring No. 2				
Depth (ft)	Depth (m)	N	Moisture (%)	Unconfined Compressive Strength (psi)	Depth (ft)	Depth (m)	N	Moisture (%)	Unconfined Compressive Strength (psi)
1	0.3	12	22	14	1	0.3	12	22	14
2	0.6	14	18	13	2	0.6	14	18	13
3	0.9	16	15	12	3	0.9	16	15	12
4	1.2	18	12	11	4	1.2	18	12	11
5	1.5	20	10	10	5	1.5	20	10	10
6	1.8	22	8	9	6	1.8	22	8	9
7	2.1	24	6	8	7	2.1	24	6	8
8	2.4	26	4	7	8	2.4	26	4	7
9	2.7	28	3	6	9	2.7	28	3	6
10	3.0	30	2	5	10	3.0	30	2	5
11	3.3	32	1	4	11	3.3	32	1	4
12	3.6	34	1	3	12	3.6	34	1	3
13	3.9	36	1	2	13	3.9	36	1	2
14	4.2	38	1	1	14	4.2	38	1	1
15	4.5	40	1	1	15	4.5	40	1	1
16	4.8	42	1	1	16	4.8	42	1	1
17	5.1	44	1	1	17	5.1	44	1	1
18	5.4	46	1	1	18	5.4	46	1	1
19	5.7	48	1	1	19	5.7	48	1	1
20	6.0	50	1	1	20	6.0	50	1	1
21	6.3	52	1	1	21	6.3	52	1	1
22	6.6	54	1	1	22	6.6	54	1	1
23	6.9	56	1	1	23	6.9	56	1	1
24	7.2	58	1	1	24	7.2	58	1	1
25	7.5	60	1	1	25	7.5	60	1	1
26	7.8	62	1	1	26	7.8	62	1	1
27	8.1	64	1	1	27	8.1	64	1	1
28	8.4	66	1	1	28	8.4	66	1	1
29	8.7	68	1	1	29	8.7	68	1	1
30	9.0	70	1	1	30	9.0	70	1	1
31	9.3	72	1	1	31	9.3	72	1	1
32	9.6	74	1	1	32	9.6	74	1	1
33	9.9	76	1	1	33	9.9	76	1	1
34	10.2	78	1	1	34	10.2	78	1	1
35	10.5	80	1	1	35	10.5	80	1	1
36	10.8	82	1	1	36	10.8	82	1	1
37	11.1	84	1	1	37	11.1	84	1	1
38	11.4	86	1	1	38	11.4	86	1	1
39	11.7	88	1	1	39	11.7	88	1	1
40	12.0	90	1	1	40	12.0	90	1	1
41	12.3	92	1	1	41	12.3	92	1	1
42	12.6	94	1	1	42	12.6	94	1	1
43	12.9	96	1	1	43	12.9	96	1	1
44	13.2	98	1	1	44	13.2	98	1	1
45	13.5	100	1	1	45	13.5	100	1	1

Future Work



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- ◆ Dames & Moore Lebrón, *Geotechnical Engineering Report on Slope Evaluation for proposed P.R.- 66 San Juan - Canóvanas, P.R., Puerto Rico Highway and Transportation Authority.*

Acknowledgment

- ◆ Thanks for the interest and help provided by the following persons:
 - * Dr. Juan B. Bernal
 - * Sra. Lydia Mercado
 - * Dr. Hernán Santos
 - * Ing. Migdalia Tirado
 - * Ing. Edgardo Pagán



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Transportation Options of Finished Vehicles

Gustavo Toledo
Sergio Pujols



Project Overview



- Transport finished vehicles from the assembly facilities in Sacramento, California to the maintenance facilities in Guaynabo, Puerto Rico.
- The transportation should be safe and cost effective.
- Special machinery available to load, unload and transport the vehicles will be suggested.
- Different land routes are available to transport the vehicles.
- The process should be done within schedule.

Problem Statement



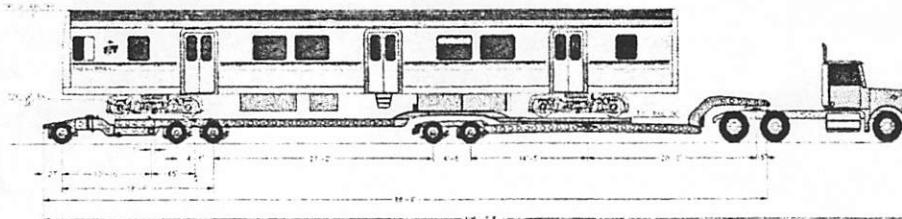
- Transport the Tren Urbano Vehicles from Sacramento, California to Guaynabo, Puerto Rico in a safe and cost effective way.
- The most critical aspect of the transportation process is the selection of the transport vehicle and the route from the port in San Juan to the yards and shops in Guaynabo.
- Transit Time Analysis is subjected to the most reliable Marine Transport Company (frequency of departures) and the route with:
 - ✓ Less overhead obstructions
 - ✓ Larger radius of curvatures
 - ✓ Less distance

Project Goals



- To develop a decision making methodology, using techniques such as rating/weighting and control convergence, to evaluate the possible alternative for the transportation of the Tren Urbano Vehicles.
- Evaluate, using the methodology developed, the proposals made by other transport companies to Siemens .
- Make recommendations so that the transportation process is safer, quicker and more cost effective.

Vehicle Information



	<i>Tren Urbano Vehicle</i>	<i>Transport Vehicle</i>
Weight (Lb)	35,109	
Length	75' 5"	88' 9"
Width	10' 6"	10'
Height	12' 5"	3'

Critical Aspects of the Inland Transportation



- Height of Vehicle plus transport should not exceed 15'-6"
 - ✓ Low bridges and overpasses (determine the route selected)
 - ✓ Some power lines and road signs might have to be temporarily removed
- Radius of curvature of the transport vehicle
- Transport vehicle should support 86,000lb
- Transport during non-peak traffic hours

Sample Transit Schedule

Sample Transit Schedule	
Transportation Process	Time
Land transport from Sacramento to Jacksonville, FL	7 days
Awaiting barge/loading	9 days
Ocean transportation to San Juan	6 days
Off loading/clearance	1 day
Trucking to job site/Return trailer to Port of San Juan	2 days
Return ocean transportation to Jacksonville	6 days
Truck transportation from Jacksonville to Sacramento	7 days
Total turnaround time for trailer	32 days

Product Design Specifications



● Performance

- ✓ The best performance is achieved when using a Ro/Ro Cargo Vessel and Low Boy Flat Bed Trailers:
 - The cranes in all piers of Puerto Rico are not designed to handle the dimensions of this vehicles.
 - Ro/Ro Cargo Vessels makes the loading/unloading process faster.
- ✓ The whole transportation process should not exceed 32 days in order to be on schedule.
- ✓ The first married pair of trains will arrive on October 1999 and would serve as a practice.

Product Design Specifications (cont.)



● Target service cost

- ✓ The cost of the transporting process should not exceed the budget available.

● Quantity

- ✓ For each phase 2 - 6 transporting machines will be necessary in order to transport all the vehicles on time.
- ✓ Spare parts must be available in case of malfunction

● Time Scale

- ✓ See attached Sample Transit Schedule

On Going Work



- Obtain the best alternative for the transportation of the Tren Urbano Vehicles.
 - ✓ Best transport vehicle
 - ✓ On schedule deliveries
 - ✓ Safest and more efficient route in Puerto Rico
 - ✓ Best and more reliable marine transport company

FOR MORE INFO

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Future Plans



- Obtain more information through interviews with people from the design area of ACT
- Visit Siemens assembly facilities at Sacramento, where valuable information will be more available.
 - ✓ Proposals made by other companies in regard to the transportation of the vehicles. If possible visit this companies.
 - ✓ Storage space available for the vehicles until they are transported to Puerto Rico.

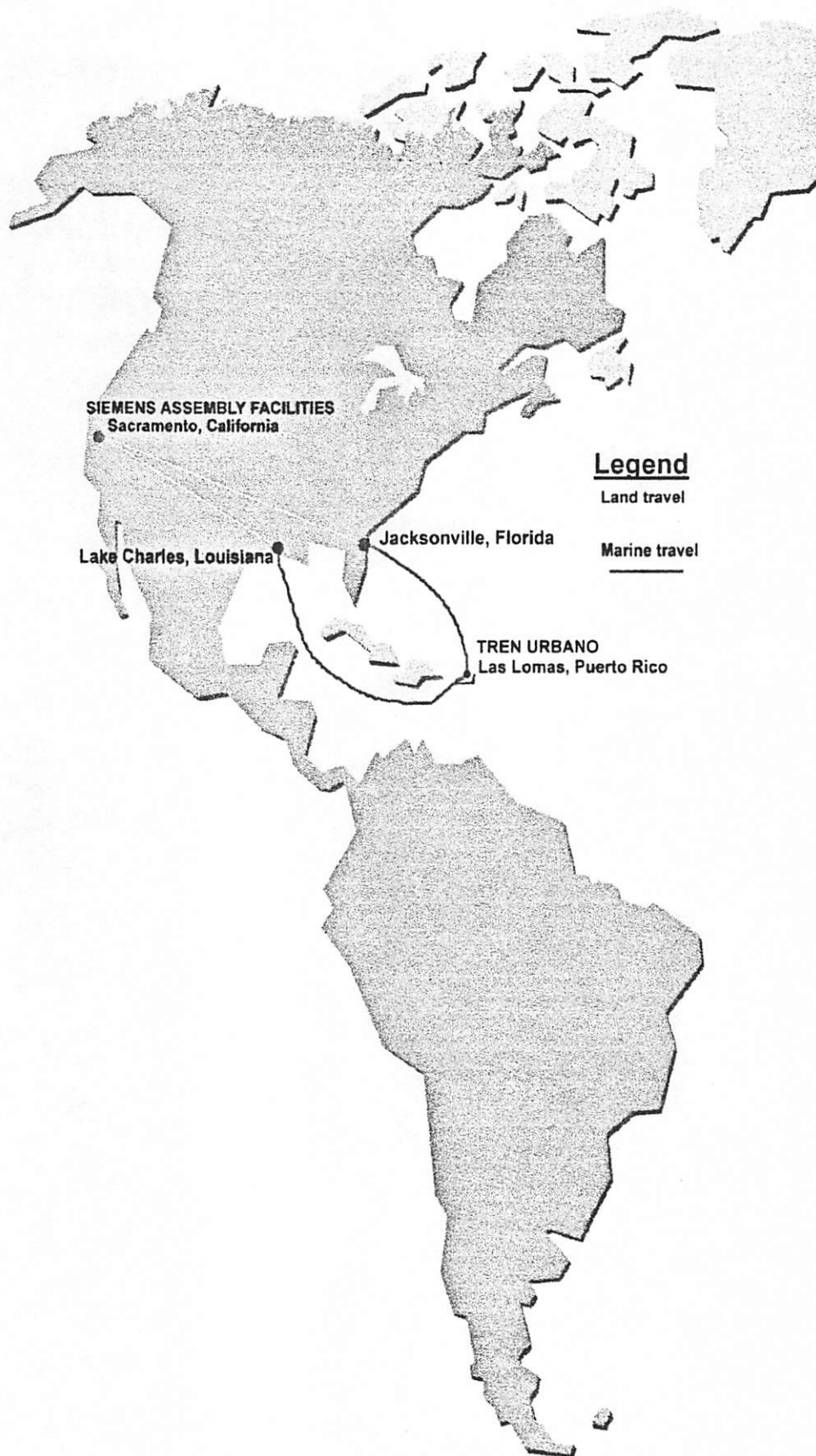
Special Acknowledgment

- Dr. Iván Baigés
- Eng. Dirk Rösler
- Dr. Benjamin Colucci
- Lorraine Lerman
- Eugenio Vélez
- Eng. Miguel A. Rodríguez del Valle
- Lucas Montañez
- Eng. Janice Martinez

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Analysis of Construction Claims Process in the Río Piedras Design/Build Contract



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Civil Engineering Department

Dr. Antonio A. González
Academic Advisor

Objectives

- Principal: Reduce the incidence of claims and disputes in the Design/Build Contract of Río Piedras.
- Examine the causes of claims in the Design/Build Contract of Río Piedras.
- Study the Advantages and Disadvantages of Design/Build Contract in the area of claims.

Design/Build Construction Methods

- Type A: Design Professional as Primary Contractor
- Type B: Contractor as Primary Contractor
- Type C: Design Professional/Contractor Joint Venture as Primary Contractor
- Type D: Design/Build Organization as Primary Contractor

Advantages to the Client of the Design/Build Method

Advantages	A	B	C	D
Reduction in Total Delivery Time	✓	✓	✓	✓
Reduction in Total Project Costs	✓	✓	✓	✓
Single Source of Responsibility	✓	✓	✓	✓
Inventive Design Solutions	✓	✓	✓	✓
Reduction in Project Management Stress	✓	✓	✓	✓
Reducing the Incidence of Claims through Negotiation	✓	✓	✓	✓

V Encuentro UPR/MIT sobre el Tren Urbano

January 7 -15, 1999

Slide 4 *Advantages to the Client of the Design/Build Method*

Reasons why design/build **Reduces Total Delivery Time**:

1. Reduces construction documentation:
 - a) Overlapping enables the contractor to break ground sooner than if he had to wait until all construction documents were completed in the usual sequence by the designer professional.
 - b) Varying the content or extent of design services enabling the construction phase to begin sooner depending on the experience of the contractor on a particular building type.
2. Collaborative decision-making by the design professional and the contractor. In design/build projects, the contractor has information from the start and can make basic design decisions. Decisions are made quickly, work can begin sooner and questions that arise during construction can be resolved more expediently.
3. Reduction in schedule delays caused by the state of the documents, drawings and specifications. Elimination of responsibility for preparation of the bid package. Matters in the design/build firm are handled less formally. Reduced number of change orders because the parties are in constant communication with each other.

The client can **Reduce Total Project Costs** by:

1. Reducing project delivery time
2. Reducing project design costs, the designer has to spend less time preparing drawings and specifications and administrating the construction of the project.

Single Source of Responsibility:

1. The arguments over responsibility for errors or omissions, faulty performance, or coordination problems are eliminated since the primary contractor is responsible to the client for errors in both the design and construction of the project.
2. The client's management and administrative burden is reduced since he only has to deal with the primary contractor for all decision-making activities.
3. Protection from liability of implied warranty on the quality of the design drawings and specifications to the contractor, because the contractor obtains the drawings

and specifications from his design associate (not from the client). Protection from liability of actions made by the owner's agent (designer).

Inventive Design Solutions on various programmatic, design and construction problems that typically arise on the project; resulting from the close communication of the design professional with the contractor in a design/build project.

The design/build methods reduce the client's **Project Management Stress** by reducing the total project delivery time and cost, the number of principal players with whom the client must interact, the number of meetings with key project personnel, and the questions concerning the responsibilities of the design professional and contractor.

If the design/build firm is chosen after careful negotiation and discussion between the client and the firm, many of the issues that are likely to give rise to problems on projects that are bid can be resolved during the design/build negotiation stage; **reducing the Incidence of Claims in Projects**. It gives the parties the opportunity to get to know one another and to understand their mutual concerns and goals, to create and foster good communication channels and to become familiar with project requirements, constraints, and probable costs.

Advantages to the Client cont.				
Advantages	A	B	C	D
"Independent Professional Advisor" to the Client	✓			
Emphasis on Construction Management		✓		
Direct Access to Both Design Professional and Contractor			✓	
Design/Build with a Proven Track Record				✓
Efficient In-House Communication			✓	
Experienced Internal Management Structure				✓

7 of 10 slides UPR/MIT sobre el Tren Urbano January 7 -15, 1999

Slide 5 *Advantages to the Client (cont.)*

The Type A design/build client contracts with a design professional, primary contractor, who is responsible for all design and construction services required to complete the project. The Type A design/build method gives the client the advantage of maintaining a design professional in the traditional role of **Professional Advisor** to the client.

Emphasis in Construction Management

In the Type B design/build method, the client deals directly with the contractor for all design and construction services required for the project. This method enables the client to directly control his relationship with the construction manager/contractor.

Direct Access to Both the Design Professional and the Contractor

In Type C design/build, the client contracts with the design professional/contractor joint venture for all design and construction services for the project. The client enjoys direct communication with and control over both the design and construction components of the project, a position not unlike that in a traditionally structured construction project. The client may receive responses more quickly, regardless of the nature of the inquires.

Experienced Internal Management Structure

In type D design/build, the design professional and the contractor form a separate legal entity, often a corporation or some form of partnership which has a legal existence all its own. The client contracts with the design/build entity for all design and construction services required for the project. The design/build organization often has an experienced internal management structure, a proven track record on similar projects, and a highly efficient in-house communication. The type D organization is better able to entirely focus on project-related issues. Internal management issues that may arise in Type C structures are likely to have already been resolved.

The Type D firm is in existence for a longer period of time than the other design/build arrangements, since the latter are generally formed for specific projects.

Design/Build with a Proven Track Record

In the Type D method, the client contracts an organization with a proven design/build track record. The other three design/build arrangements permit the most suitably qualified design professionals and contractors to work together on a given project. Since these design/build entities have a temporary existence, they are not able to develop the same kind of in-house, long-term working relationships that a Type D organization fosters.

Efficient In- House Communication

Type D firms possess all required design and construction services in-house. Disputes between the design and construction parties are less likely to occur in the Type D design/build method, because in types A, B, or C design/build, the firms have to establish good communication channels and reconcile their separate professional, business, and management approaches.

 6				
Disadvantages to the Client of the Design/Build Method				
Disadvantages	A	B	C	D
Loss of Design Professional as Independent Professional Advisor	✓	✓	✓	✓
Limited Connection with the Party Responsible for the Construction Management	✓			
Reduction in Design Quality		✓		
Fractured Management Structure			✓	
Inflexibility to Meet Specific Project's Needs				✓
V Encuentro UPR/MIT sobre el Tren Urbano January 7 -15, 1999				

Slide 6 Disadvantages of the Design/Build Method

Loss of Independent Professional Advisor

The greatest disadvantage to the client using the design/build method is the loss of the design professional as independent professional advisor. The design professional cannot represent the client fairly if he has a financial interest in the project. In the traditional construction method, the designer has the duty to work solely for the best interests of the client in the design and preparation of the construction documents for the project, consistent with the client's programmatic, budgetary, and other constraints.

Limited Connection with the Party Responsible for Construction Management

In the Type A design/build, the client enjoys a contractual and close working relationship with the design professional; but his relationship to the contractor is diminished since there is no contractual relationship between them and it is not in the design professional's best interest to permit the client to communicate directly with the contractor.

Reduction in Design Quality

Some say that the design quality of a Type B design/build project may be inferior to that of either a Type A design/build project or a traditionally structured project; based on the assumption that contractors do not tend to make design decisions as competently as design professionals, and that the design professional's role in a Type B project may be reduced.

Fractured Management Structure

In a Type C design/build project, the design professional/contractor joint venture must be internally structured to "speak with one voice" on administrative and management issues or the management may appear fractured, and the client may end up interacting with one or the other of the parties, or with both parties, on various design or construction issues. A fractured management structure puts the client in a traditionally structured project without an independent professional advisor to serve as his representative in construction matters.

Inflexibility

Of the four design/build methods, Type D is the least able to adapt to the particular needs of a client or project since it is geared toward a long-term or permanent association. They do not tend to affiliate with other design professionals or contractors to meet the project's needs because their business objectives are to develop certain design and construction capabilities and experience in-house. While their organization's strength lies in its tested internal working relationships and experience on certain projects, it limits their capabilities to meet project's specific requirements.

					7
Advantages to the Contractor of the Design/Build Method					
Advantages	A	B	C	D	
Increased Control over project		✓	✓	✓	
Greater Job Satisfaction		✓	✓	✓	
Minimizing Risk and Project Uncertainty	✓	✓	✓	✓	
Improved Communication with the Design Professional	✓	✓	✓	✓	
Opportunity to Increase Profits	✓	✓	✓	✓	
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					8
Advantages to the Contractor cont.					
Advantages	A	B	C	D	
Selection of Most Appropriate Design Professional		✓			
Reducing In-House Staff		✓			
Increased Marketing Strength			✓	✓	
Fostering Team Spirit				✓	
Evaluating Cost, Schedule, and Quality Issues				✓	
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Slide 7 *Advantages to the Contractor of the Design/Build Method*

Increased Control Over the Project

Design/Build offers the contractor an opportunity to create rather than respond to design decisions, opportunity that is unavailable in more traditional methods of project delivery. It increases the contractor's control over a greater range of project-related activities, the most significant of which is the design process.

Greater Job Satisfaction due to the greater control the contractor assumes over the design and construction of the project.

Minimizing Risk and Project Uncertainty

Design/Build projects may be requisitioned through negotiation, design competition, or a form of bidding that requires the design/build team to submit drawings as well as estimates. The client meets with the design/build firm or its representatives to discuss project's requirements. The contractor is in direct communication with designer from the start in planning how the project can be best completed. The design/build firm is chosen on price, on willingness and ability to meet project requirements. This reduces the uncertainty that plagues traditional competitively bid projects.

Improved Communication with the Design Professional

The most important element that assures the success of any project is the effective communication between the design professional and the contractor. The closer their relationship is, the more effective is the communication between them. In a design/build project the design professional and a contractor share the same goals unlike traditional projects. Their relationship is the product of a forced marriage of the design and construction components that engenders an eagerness to work together, to solve problems when they arise, and to do so expediently.

In the design/build process the contractor may enjoy the **Opportunity to Increase Profits** over those which might normally be earned using traditional methods of project delivery. The contractor may do this by:

1. Controlling the selection of construction materials and methods
2. Reducing design and construction related activities
3. Responding quickly to unanticipated or changed circumstances

Slide 8 *Advantages to the Contractor*

Selection of the Most Appropriate Design Professional

The Type B design/build contractor selects the most appropriate design professional to meet the design requirements of the project. The Type B arrangement permits the contractor to work with a number of design professionals on a variety of projects, using the designer whom the contractor believes is best suited for each project. The contractor who is free to associate with a variety of design professionals expands his scope of services, the number and types of projects for which he is qualified to compete.

Reducing In- House Staff

Contractors find the Type B organization attractive because it neither requires them to become subordinate to the designer nor to expand his organization by adding and maintaining design staff. Type B contractors can increase their flexibility, reduce expenses, and increase profits by keeping overhead low and reducing their in-house staff.

Increased Marketing Strength

In Type C the contractor and design professional combine forces to form a joint venture; neither is a sub-consultant nor subcontracted to the other. The Type C joint venture permits the contractor and design professional to become part of a team: established, knowledgeable, and dedicated to pursuing this method of project delivery.

Type D design/build fosters the team spirit among staff that is so critical to the success of any project. It is harder to develop team spirit in the other design/build arrangements where the design and construction elements have very different business, professional, or commercial goals. It is less likely that conflicts between the design and construction components arise in a Type D organization.

Evaluating Cost, Schedule and Quality Issues

The contractor of a Type D organization is better able to evaluate the cost and schedule implications of his own work and of requested changes by the client. This is because:

1. The individuals involved in the evaluation work are part of the same organization.
2. The Type D design/build organization has established a set of design, construction and quality standards based on years of experience.
3. Conflicts over cost, schedule, and quality are likely to be resolved more quickly since the same management structure and philosophy which guides individual design and construction decisions also governs conflict situations.



9

Disadvantages to the Contractor of the Design/Build Method

Disadvantages	A	B	C	D
Gaps in Insurance Coverage		√	√	√
Increased Risk of Nonpayment	√			
Decreased Authority and Credibility with the Client	√			
Responsibility for the Acts and Omissions of the Design Professional		√	√	√

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Disadvantages to the Contractor cont.

Disadvantages	A	B	C	D
Loss of Certain Legal Defenses		√	√	√
Difficult Issues of Management and Control			√	√
Joint and Several Responsibility			√	
Complex and Time-Consuming to Establish			√	√

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Slide 9 *Disadvantages to the Contractor of the Design/Build Method*

Gaps in Insurance Coverage

The contractor and design professional can structure their relationships in such a way that each will bear the risk of liability associated with his own activities; but in case of a lawsuit, if the loss exceeds the ability of the negligent party to pay, the balance falls on the business associate.

Contractors should be aware of the gaps in their own insurance; specifically coverage on design services made by a contractor in a design/build project.

Increased Risk of Nonpayment

In Type A, the contractor has no contractual relationship with the client, his legal agreement is with the design professional. The contractor's attempt to collect payment from the design professional, either through the dispute resolution clause in his contract or through litigation, may prove fruitless if the designer simply does not have the money. The design professional often is marginally capitalized. Designers are not in position to pay the contractor for construction services until he is paid by the client.

Decreased Authority and Credibility with the Client

The contractor does not have any direct contact with the client; all their communication goes through the design professional. The designer has control over the information flow. As a result, the solutions to the everyday-problems that arise during the project delivery may appear to be the result of the designer's expertise rather than the contractor's participation.

Responsibility for the Acts and Omissions of the Design Professional

One of the greatest disadvantages in the Type B design/build method is the contractor's liability for the acts and omissions of the designer. He is responsible for all design and construction activities.

Slide 10 *Disadvantages to the Contractor (cont.)*

Loss of Legal Defenses

The contractor cannot employ the betterment rule as a defense holding the client responsible for inadequate or incomplete drawings and specifications, as is possible on traditionally structured projects. The betterment rule states that items omitted from the design documents but required on the project, must be paid for by the client.

Difficult Issues of Management and Control

In a Type C project, contractors and design professionals share responsibility and liability with respect to the client, and possibly to third parties. Each will want to control the activities of the joint venture and their own, to assure themselves that such exposure is limited. Structuring the management can be difficult since one party can veto the decision made by the other.

Joint and Several Responsibility for the Acts and Omissions of the Design Professional

The Type C Contractor may be liable for the acts and omissions of the design professional under joint venture partnership law.

Complex and Time- Consuming to Establish

A Type D design/build organization takes the greatest amount of time to establish since it is created by two or more parties contractually agreeing to pursue a common enterprise through the creation of a separate business organization or corporation, intended by its founders to continue to exist beyond a single project.

11

Advantages to the Designer of the Design/Build Method

Advantages	A	B	C	D
Greater control over project quality	√		√	√
Increased level of job satisfaction	√		√	√
Opportunity to increase profits	√	√	√	√
Field Experience	√		√	√
Greater Credibility with Clients	√		√	√

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Advantages to the Designer cont.

Advantages	A	B	C	D
Reducing the incidence of Claims by Contractors	√	√	√	√
Selection of the Most Qualified Contractor	√			
"Least Effort / Least Risk"		√		
Sharing Control Over the Project			√	√
Increased Marketability	√		√	√
Fostering Team Spirit				√

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Slide 11-12 *Advantages to the Designer of a Design/Build Method*

Greater Control Over Project Quality

The design/build method provides the designer the opportunity to participate in all aspects of the design and construction process. In design/build methods, designers can enhance the quality of the construction, they can implement changes which they would not make in a traditional project because of the time they take to document.

Direct communication between the design professional and the contractor not only enhances the designer's knowledge of construction matters, but speeds the decision-making process. When the designer is in direct contact with the contractor, these decisions are made quickly and with a greater emphasis on design quality than cost or time constraints.

A design professional may experience an **Increased Level of Job Satisfaction** through participation of a design/build method because of the greater control he has over the project quality.

The design professional may **Increase Profits** in the following ways:

- Reducing design services
- Assuming an equity against market fluctuations
- Increasing marketability and expanding the firm's client base

Field Experience

The design/build methods offer the design professionals the opportunity to work by the side of a contractor during the construction of a project, to see first-hand the actual construction tasks that must be performed, and to hear the questions and concerns raised by the contractor on a variety of matters including the information contained in the drawings and specifications, an invaluable experience.

Greater Credibility with Clients

The design/build method presents the design professional as an individual who is proficient in the art and skill of design and also, knowledgeable in the craft and science of construction.

Reducing the Incidence of Claims by Contractors

The bond that develops between the design professional and the contractor in a design/build firm is stronger than that in a traditionally structured project since both parties are striving for the same goals. The circumstances underlying most claims, such as mistrust, lack of communication, and the desire for retribution are replaced by a greater sense of cooperation. Legally, it is possible for contractors to make claims against design professionals under the types A, B, and C design/build. In fact, there are sources of potential conflict in these relationships which do not exist in traditionally structured projects, but the likelihood of these claims are less, specially if the firm has a continuing existence beyond a single project.

Selection of the Most Qualified Contractor

The Type A design/build designer chooses the contractor whose qualifications and experience are best suited to the project.

"Least Effort/Least Risk"

The Type B arrangement involves the least effort/least risk. The design professional has no contractual responsibility to the client. He is not responsible for the activities of the contractor or construction-related issues. Since no legal entity is established all that is required to create this type of design/build firm is a properly drafted contractual agreement establishing the terms and conditions between the contractor and the designer.

Sharing Control Over the Project

The designers share control with contractors over all aspects of the project, including those areas which they normally do not participate. The design professional is in a better position to influence construction decisions in Type C design/build than in traditional methods of project delivery. He can make sure that the design issues are given equal weight and that decisions during the construction phase are not made without regard to the project's original design intent.

Design Professionals may find an **Increase in their Marketability** by participation in a Type C design/build project.

Fostering Team Spirit

"Awareness of goals and priorities by the company staff and a close working relationship between its members fosters the team spirit which is so critical to the success of any project." (Twomey, 1989)

Disadvantages to the Designer of the Design/Build Method

Disadvantages	A	B	C	D
Responsibility for the Acts and Omissions of the Contractor	✓		✓	
Gaps in insurance Coverage	✓		✓	
Large Start-Up Costs	✓			✓
Decline in Status	✓	✓	✓	✓
Assuming the Burden of Construction Management	✓			

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Disadvantages to the Designer cont.

Disadvantages	A	B	C	D
Reducing the Scope of Design Services	✓			
Isolation from the Client	✓			
Conflicting Obligations	✓	✓		
Difficulty Establishing Management and Control			✓	
Joint and Several Responsibility			✓	
Difficulty Establishing the Design/Build Organization				✓

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Slides 13-14 *Disadvantages to the Design Professional of Design/Build Method*

Design Professionals who establish design/build organizations are faced with substantial star-up costs.

Many design professionals engaged in design/build projects fear a **Decline in Status** before the eyes of the client and the public.

Assuming the Burden of Construction Management

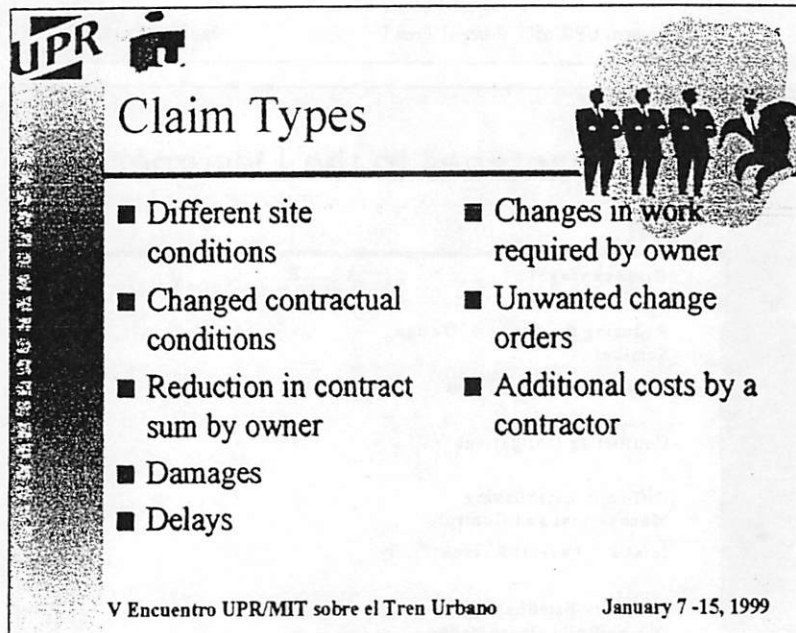
In Type A design/build, the designer as the primary contractor, is responsible for the design and the construction of the project. The design professional must assume the role of administrating the construction contract and serve as construction manager to the client.

Reducing the Scope of Design Services

The design professional may become dissatisfied with his reduced influence and with the extent of his involvement on the project. Many of the services required on a traditionally structured project are not required on design/build project.

Conflicting Obligations

The Type B designer while retained by the contractor, may feel that this responsibility is secondary to the traditional loyalty to the client.



UPR 

Claim Types

- Different site conditions
- Changed contractual conditions
- Reduction in contract sum by owner
- Damages
- Delays
- Changes in work required by owner
- Unwanted change orders
- Additional costs by a contractor

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Slide 15 *Claim Types*

Types of Damages:

- Liquidated
- Compensatory
 - Direct Damages
 - Damages Awarded for Personal Injury
 - Damages Awarded for Wrongful Death
 - Damages for the Destruction of Property
- Punitive
- Consequential

Types of Delays:

- Classic
- Serial
- Concurrent
- Excusable

Unwanted Change Orders

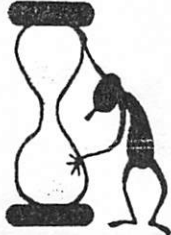
The Contractor can contest an unwanted change order in two ways:

1. By claiming the change is beyond the nature and scope of the contract
2. By requiring a cost or credit for the change that is heavily in his favor (a high cost or a low credit)



16

Time Limitations on Claims



- Statutes of Limitations
- Statutes of Repose

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Slide 16 *Time Limitations on Claims*

Statutes of Limitations state that no claim can be maintained against a party unless that claim is brought within a specific period of time.

Statutes of Repose begins at a point established by the statute, regardless of whether or not a breach of duty has occurred.



13

Dispute Resolution Methods for the Río Piedras Contract

- Partnering Sessions
- Dispute Review Board (DRB)



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Slide 18 *Dispute Resolution Methods*

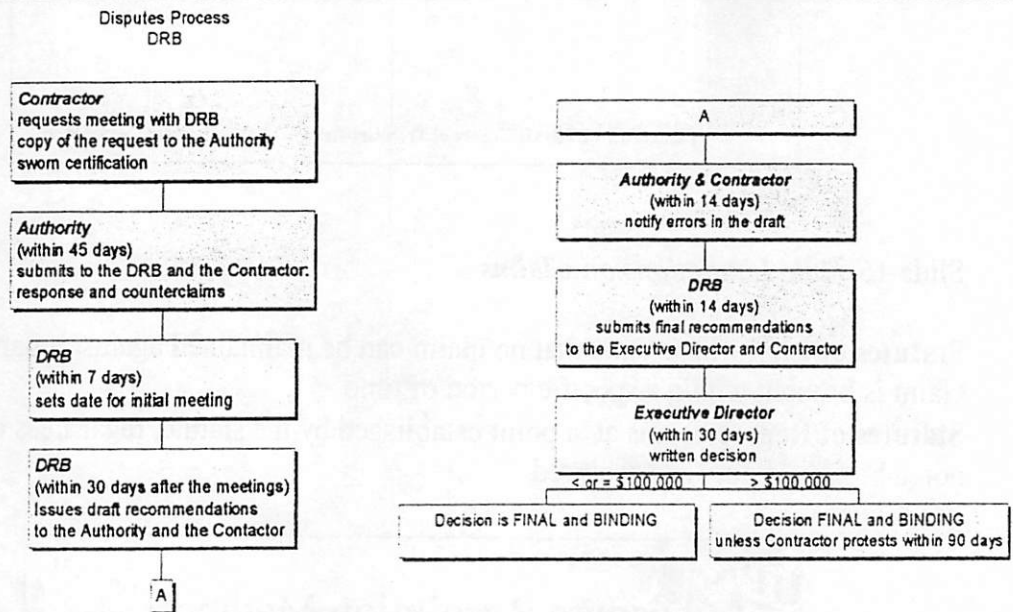
Partnering - defines the owner-contractor relationship where they agree to share the risks involved in completing the project and to establish and promote a nurturing partnership environment.

Dispute Review Board - When they can not solve the Dispute after a determined period of time, the DRB will study the case and make recommendations to the Executive Director, who will make a decision on the matter. The DRB is will have three members which shall be selected as follows: first each party will nominate three individuals, then each party will select a member from the other's list. The third member will be chosen by the first two.



19

DRB Process



Preliminary Conclusions

- Claims and Disputes arise on virtually all construction projects. In a Design/Build Project most disputes are solved amicably by the parties themselves because they are part of the same organization, they share the same goal: cheaper, better, faster.
- The time limits in the DRB Method should be shorter. Use an alternate method for claims less than \$100,000.

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Future Work

- Interview members of the DRB, the Contract Manager, members of the Tren Urbano Claim Board.
- Examine the claims that have been filed in the Río Piedras Station.
- Analyze the causes of these claims and find the way to prevent and solve them as quickly as possible.

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FARE COLLECTION SYSTEMS

By:

Carmen M. Centeno Calero
UPR- Mayagüez Campus
January 12, 1999



Problem Statement:

- The fare collection system is used across the United States and the world for public roads, subways, trains and buses.
- Its more convenient, efficient and quick to use electronic toll collection to pay fares.
- Is necessary to study the technologies available for electronic toll collection.
- Then, if necessary, recommend improvements to the fare collection for the Tren Urbano in Puerto Rico.



*Using simulation to estimate the
Tren Urbano operations
resources*

Damary Rivera Ortiz
Industrial Engineering
UPR - Mayagüez Campus



Abstract

This research proposes the use of simulation to estimate the resources (human/machine) requirements for operations and maintenance of Tren Urbano. The simulation model will provide the opportunity to analyze the behavior of the system under different scenarios.

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Introduction

In the development of a new transit system, operations resources planning (ORP) needs to receive special attention. Traditionally, ORP does not consider the dynamics and stochastic nature of such system. Through a simulation of the real system, these elements can be considered.

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Objectives

Through the building of a simulation model, we will estimate:

- + Required transportation and maintenance resources
- + Utilization of estimated resources
- + Proportion of total time per activity
- + Operations workforce cost

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Literature review

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Work done

- ✓ Familiarize with Tren Urbano system.
- ✓ Define points of data gathering.
- ✓ Collect data.
- ✓ Familiarize with SIMAN.

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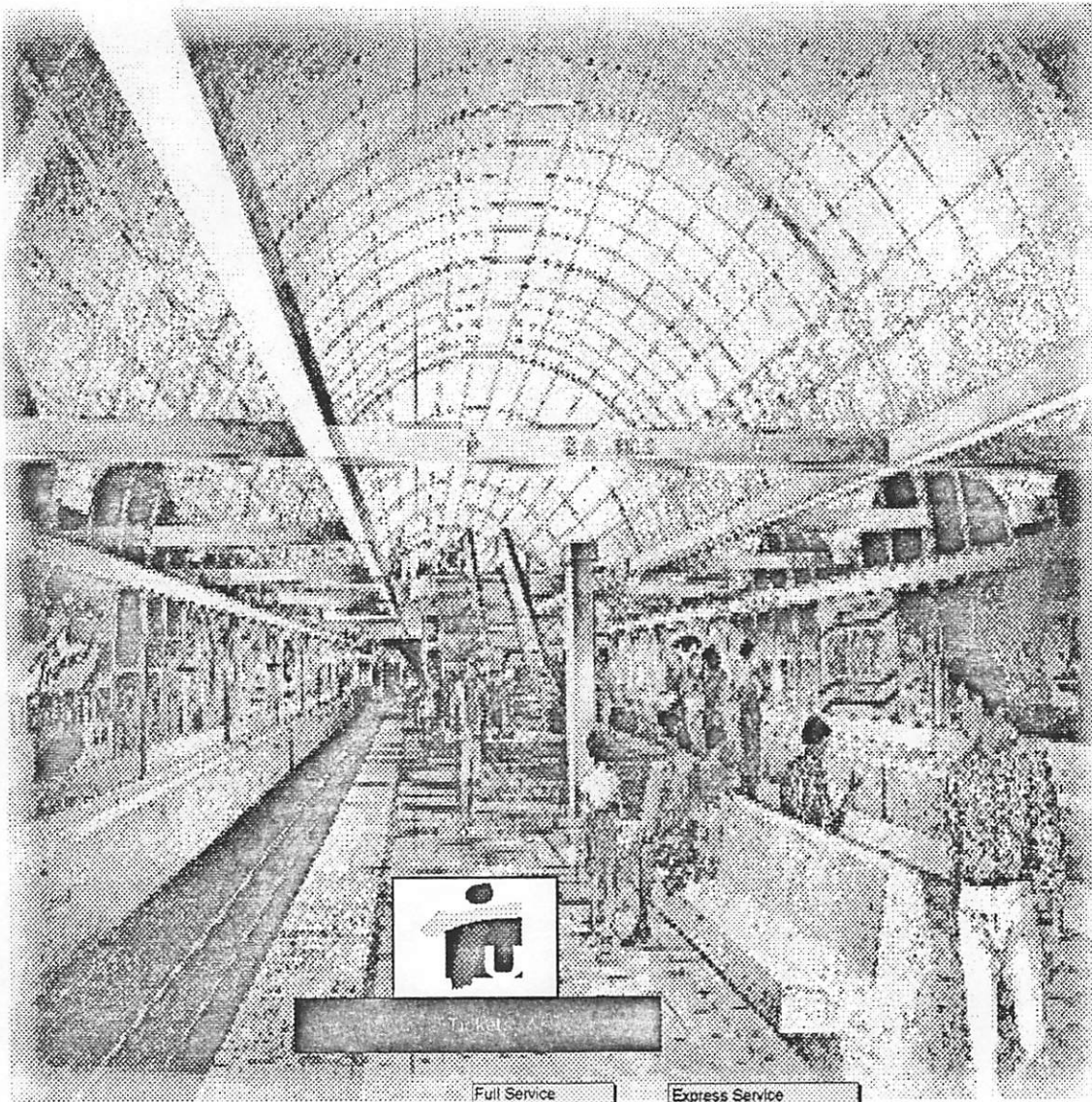


Work to be done

- ✓ Build simulation models, and animation.
- ✓ Input analysis.
- ✓ Model verification and validation.
- ✓ Output analysis.
- ✓ Estimation of:
 - Required transportation and maintenance resources
 - Utilization of estimated resources
 - Proportion of total time per activity
 - Operations workforce cost

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Simulation Model: *UPR Station*



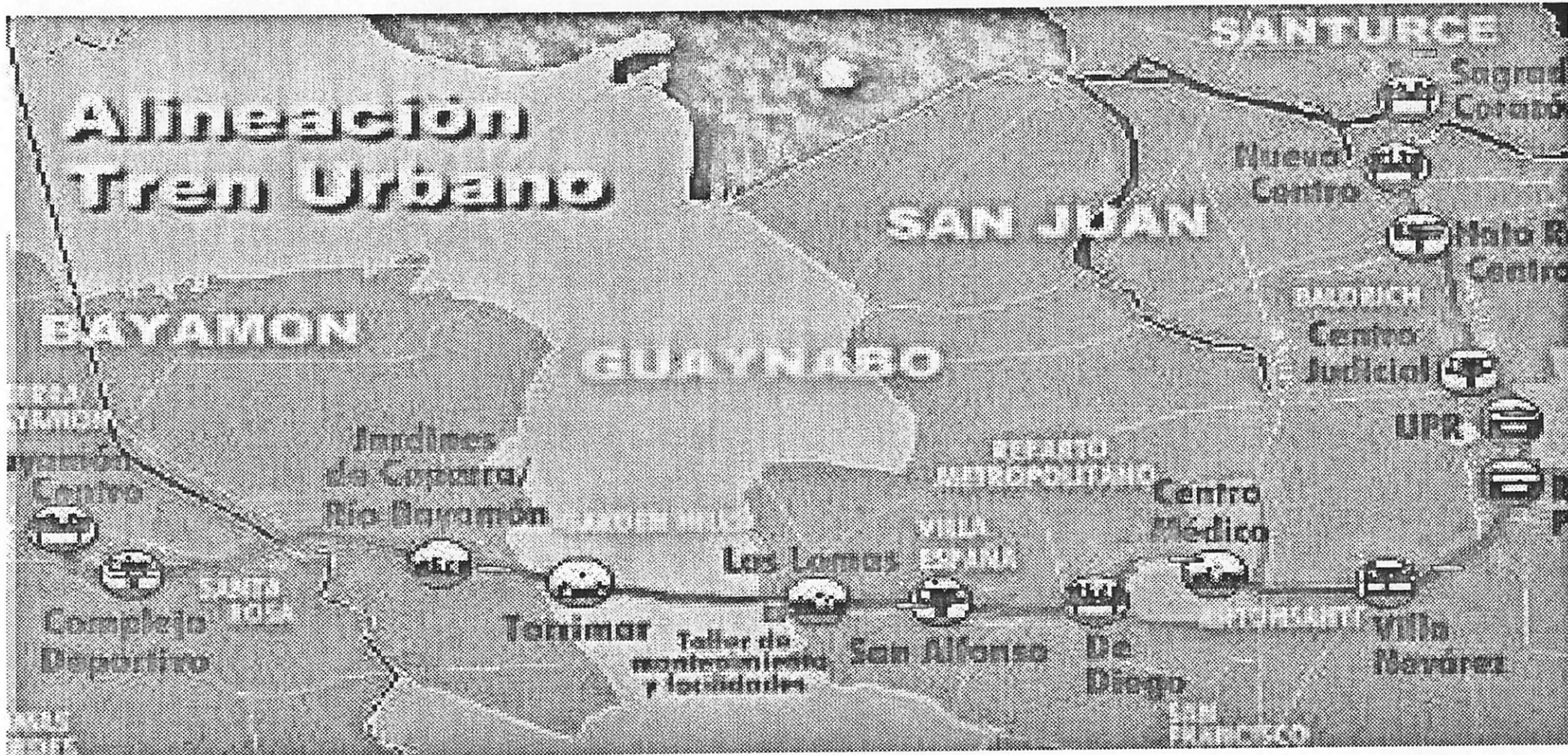
Number Serviced
Full Service 19
Express 36

**Avg Time
in System** 10.27

Time 09:44:27



Simulation Model: *Tren Urbano Alignment*





**V ENCUENTRO UPR/MIT
TREN URBANO, PUERTO RICO**
Carlos Rodríguez Colón
Escuela de Arquitectura
Universidad de Puerto Rico
Recinto de Río Piedras

Escuela de
Arquitectura

TREE PLAN



TRAIN ROAD ENVIRONMENTAL EXCHANGE PLAN



TREE PLAN



*"La ciudad de nuestros días está llegando ya a término debido a sus excesos...
Cuando necesitamos un modelo de ciudad nueva, lo encontramos en términos
orgánicos. Formará parte de la tierra...
La arquitectura va profundizando cada vez más en la naturaleza, que es la
madre de la arquitectura, sin la cual no existe cultura"*

Frank Lloyd Wright

Los viaductos, en el ámbito aéreo, por donde pasará la alineación del Tren Urbano, tendrán un gran impacto visual que afectará nuestro medio ambiente, por ser una estructura que cruzará por zonas urbanas en el área metropolitana que proyecta ser una masiva mole de hormigón en medio de estos espacios. Además de crear espacios de uso perdido como lo podría ser el área debajo de estos viaductos.

El propósito del TREE PLAN tiene como objetivo crear un intercambio favorable entre los viaductos y el medio ambiente que lo contenga.



TREE PLAN



Con la intención de reducir este impacto masivo se propone la implantación de áreas verdes en lugares donde, el área debajo de los viaductos, no tengan un uso determinado y surjan como espacios remanentes de la construcción en lugares cercanos a zonas residenciales o comerciales los cuales puedan ser habilitados como parques lineales, parques pasivos, o simplemente áreas verdes de contemplación que reduzcan el impacto visual y aporten significativamente a las zonas donde se encuentre. El TREE PLAN propone además diseñar un modulo de jardinera que se adose a las dovelas que funcione conjuntamente a unos sistemas mecánicos de drenajes y rociadores de agua que a su vez su mantenimiento sea casi ninguno.



TREE PLAN



Estas jardineras adosadas a las dovelas del viaducto en la alineación, crearán una franja continua de vegetación a nivel aéreo que proporcionarán un balance visual entre la rigidez y lo masivo del viaducto del tres y la vegetación que esta pueda aportar como intercambio entre lo construido y lo no construido; como el agente de vida que pueda utilizar para convivir con el medio ambiente que la contiene.

El TREN URBANO será un nuevo ejemplo de sistemas de transportación pública en el país. Se han producido esfuerzos con exitosos resultados en el estudio y análisis de otros sistemas de transportación similares al nuestro alrededor del mundo de donde se han adoptado las mejores ideas y soluciones para ser utilizadas en nuestro caso.



TREE PLAN



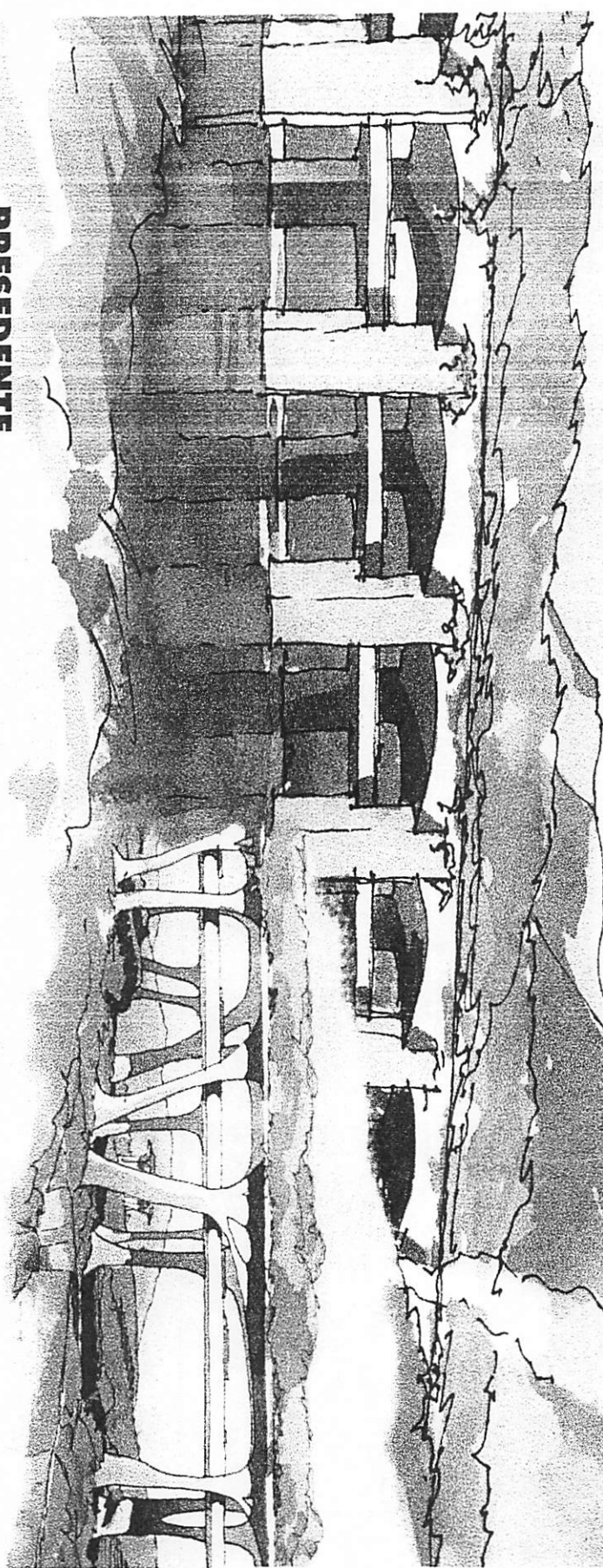
Al culminar las faces que completan la alineación de nuestro tren debemos servir de igual manera como ejemplo de soluciones a problemas que puedan ser utilizados en futuras planificaciones tanto en nuestra isla como en otras partes del mundo. A mi juicio, creo que la implantación de sistemas como el que propongo puede ser uno de estos casos, ya que el TREE PLAN podría ser utilizado en otros sistemas de transportación en el país, como autopistas, puentes vehiculares o peatonales, o en otros lugares que con sistemas de transportación similares al nuestro que tengan la intención de crear soluciones dirigidas al bienestar de su pueblo.

Escuela de **Arquitectura**



TREE PLAN

PRESEDENTE



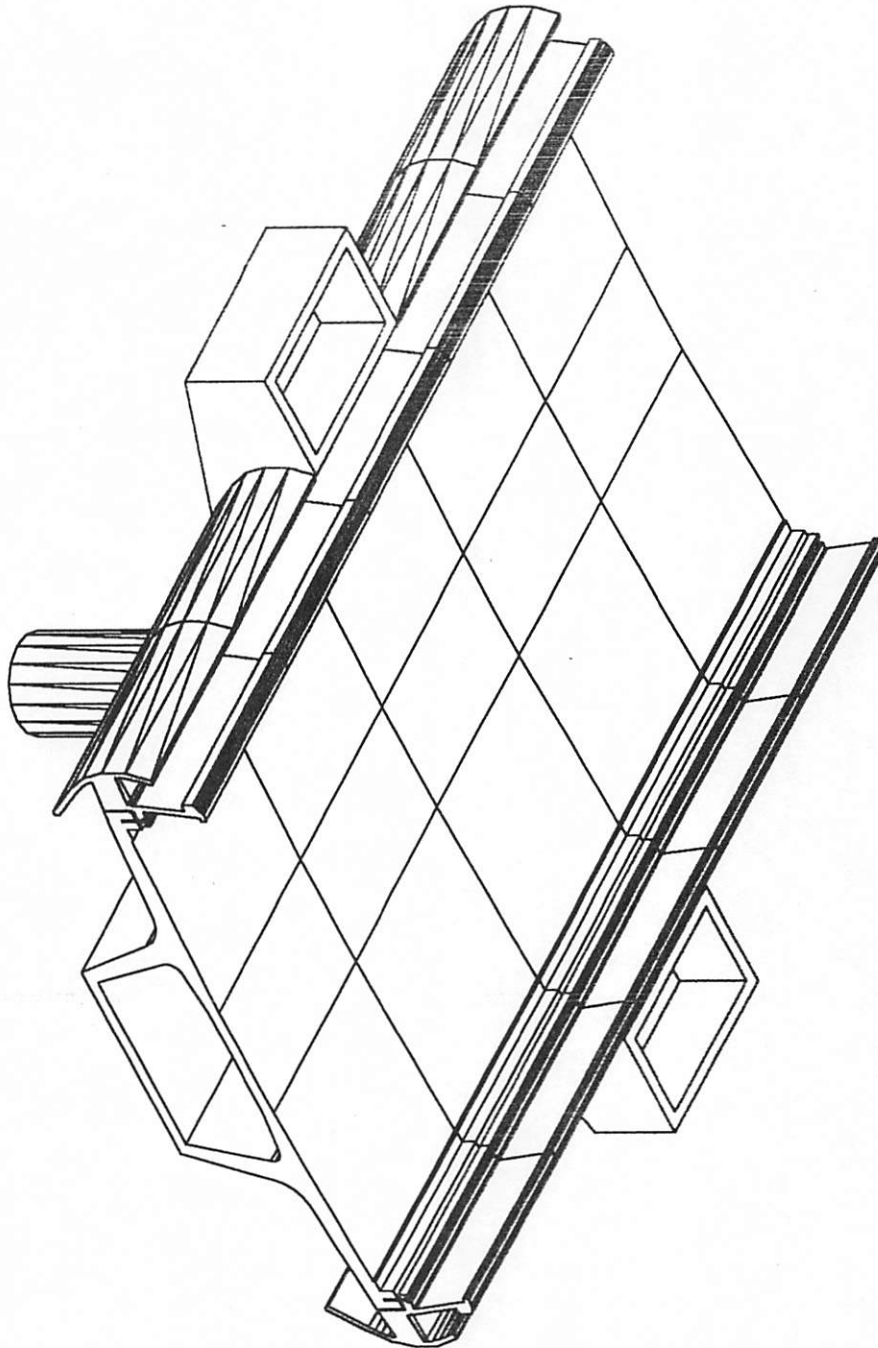
UPR



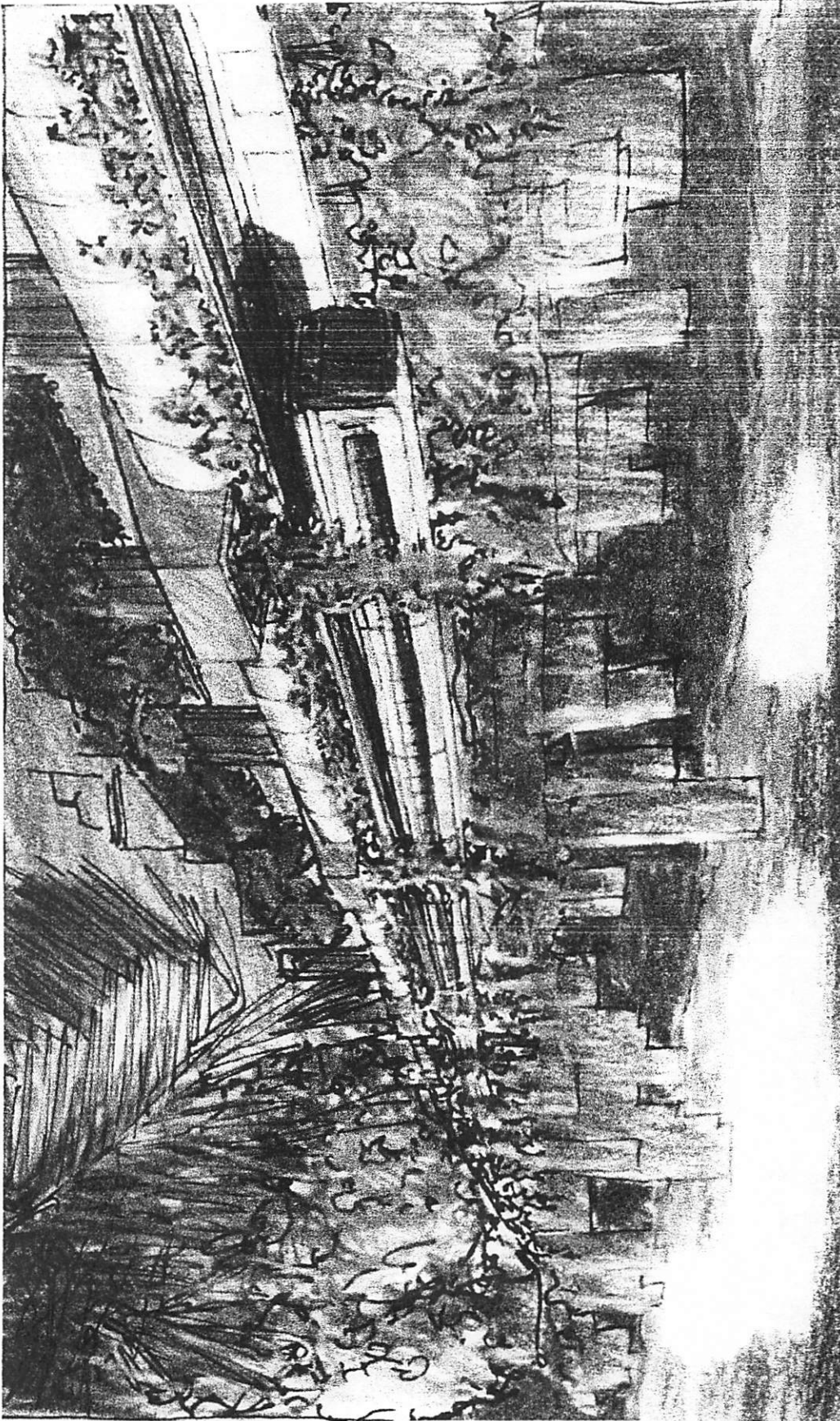
Escuela de **Arquitectura**



TREE PLAN



Escuela de **Arquitectura**



TREE PLAN

UPR





TREE PLAN



THE MAN IS LIKE A TRAIN

At **20**, he is like a **Local**.

It stop at every station.

At **30**, he is like the **Spetial**.

It stop only at the large towns.

At **40**, he is like the **Express**.

It stop at the big cities only.

At **50**, he is like the **Old Locomotive**.

It stop often to water.

A **60**, he doesn't **Leave anymore**.

It remains in the the yard.



TREE PLAN



BIBLIOGRAFIA

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Infraestructura. Malcon Collen

AGRADECIMIENTOS

Fernando Rojas
Esteban Sennyey
Rafael Marrero
Lydia Mercado
Hyran Matos

Escuela de Arquitectura

Prediction of Ground Deformation Caused by Underground Construction of the Tren Urbano in Río Piedras

Stacked Drift Method

by Luis Urquiza Román
Civil Engineering Department
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Abstract

The section 7 alignment of the Tren Urbano will be constructed underground over a total length of 1500m extending from Villa Nevárez to Hato Rey. The entire section will be constructed within deep alluvial deposits of interbedded stiff clays and sandy clays, refers to Hato Rey formation. The project includes 3 distinct tunneling methods.

The most challenging section of the project is the construction of the Río Piedras station which comprises a 14m diameter cavern. Stacked drift construction will be used to support the excavation of the main cavern.



Abstract Cont.

One of the principal factors affecting the design of the mined tunneled is the control of ground deformations necessary to avoid damage to surrounding buildings and utilities.

The main goal of this project is to interpret field measurements of ground movements in relation to the stacked drift construction method.

Objectives

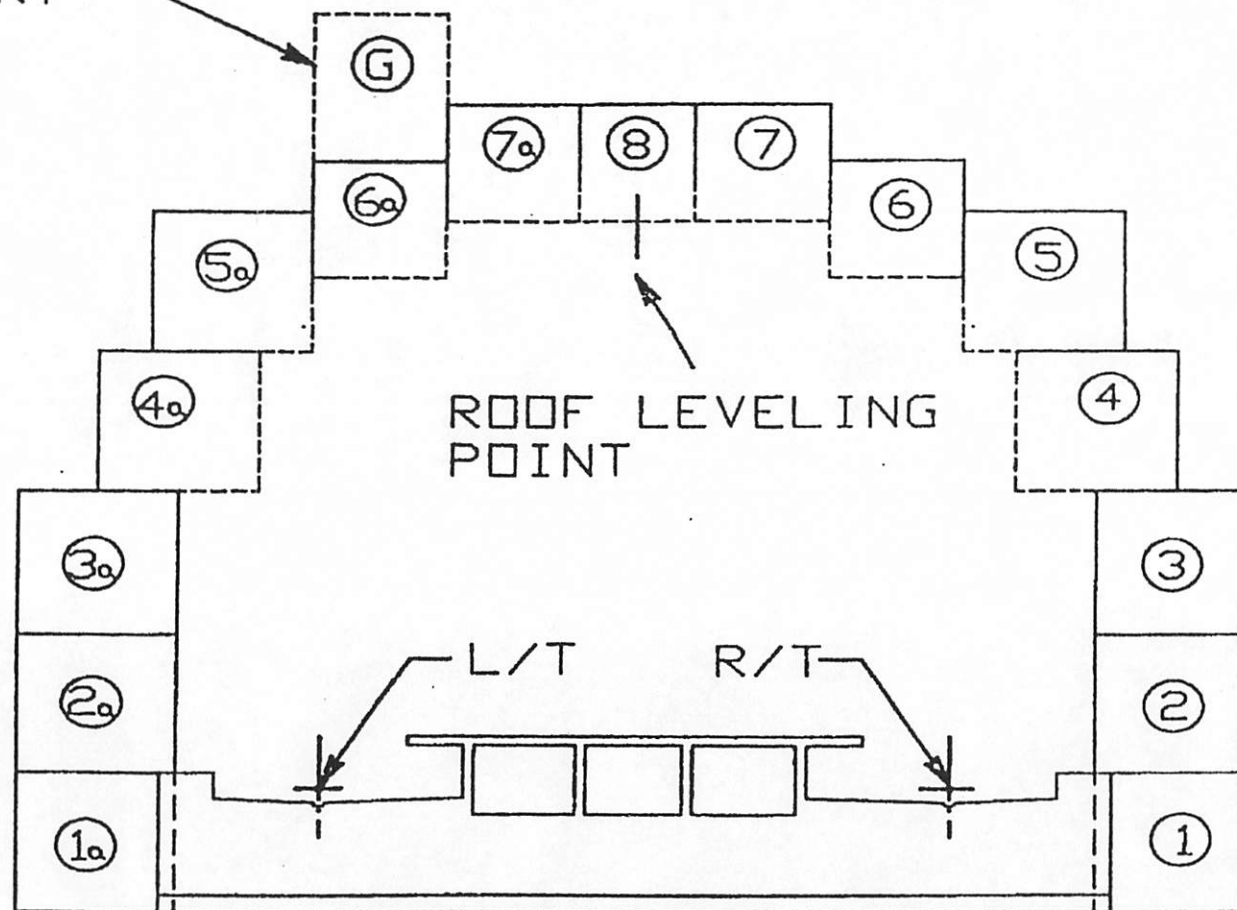
- Interpret ground field measurements of ground movements in relation to the stacked drift construction method.
- Evaluate methods of predicting ground movements for tunneling excavations with the stacked drift method.
- Apply these findings in relation to the future underground construction for the extension of Tren Urbano.

Stacked Drift

- Overlapping concrete-filled drifts used to form a structural arch.
- Drifts: a total of 15 squares with an average size of 3m by 3m.
- Temporary support provided by steel beams and posts (spaced 1.2m cc).
- Wood lagging on the inside faces of the drifts used to retained soil.
- Bottom-up construction sequence.

Stacked Drift Method

GROUTING
GALLERY



Site Stratigraphy

■ Fill:

- ◆ Man-placed fill associated to urban development.
- ◆ Mostly loose to medium dense silty sand or medium to stiff silty clay

■ Hato Rey Formation:

- ◆ Divided in three main layers: upper clay, middle sand and lower sand
 - ◆ Upper Clay
 - Low to high plasticity clays
 - Some lenses of silt and clayey sand

Site Stratigraphy Cont.

- ♦ Middle Sand

- Alternate layers of silt, silty sand and clayey sand

- ♦ Lower Sand

- Texture composition and density different from middle sand
 - Interbedded sands and clayey sands

- Aguada Limestone:

- ♦ Located at a depth of about 23 to 26 m
 - ♦ Slightly to moderately weathered

Settlement Estimates

- Settlement of the Stacked drift Construction are associated to:
 - ◆ Dewatering: 3 mm to 6 mm
 - ◆ Stress relief due to excavation
 - ✦ Bottom-up-down construction: 30 mm
 - ◆ Face losses and void closure
 - ✦ Expressed as a percentage of the volume of the mined tunnel
 - ◆ Development of bearing for stacked drifts: 5 mm
- Total expected ground surface settlement: 40 mm - 45 mm
- Settlement will be controlled by compensation grouting

Geotechnical Instrumentation

- Purpose:
 - ◆ To assess ground behavior during construction and to permit implementation of settlement control measures.
- Measurement of vertical and lateral ground movement:
 - ◆ Subsurface settlement rods
 - ◆ Ground surface settlement reference points
 - ◆ Building monitoring array (BMA)
 - ◆ Inclinometers

Previous Studies

Despite improvements in tunneling methods that have occurred in the last 20 years, it is often difficult to achieve adequate control of ground deformations. Much of the difficulty relates to the complex interactions between construction procedures and ground response.

- Ground movement associated with tunneling:
 - ◆ Differences in volumes of ground loss and surface settlement must be related to volume changes occurring with the soil.

Previous Studies Cont.

- ◆ Factors that contribute to ground loss: ground conditions, groundwater, tunnel geometry and construction methods.
- ◆ Current practice generally assumes ground loss volume equal to soil volume.
- ◆ Lateral distribution of surface settlement is typically described by a gaussian distribution curve (after Schmidt, 1969).
- ◆ Similar empirical models have been developed to describe horizontal surface movements and longitudinal settlement distribution.

Previous Studies Cont.

- Damage to adjacent structures:
 - ◆ Structural damage is caused by a combination of differential vertical settlements and horizontal strains.
 - ◆ Boscardin and Cording(1989) proposed a simple design chart for estimating the damage potential correlating measured damage with measured foundation displacement.
 - ◆ Mair (1996) have proposed that damage due to tunneling can be more reliably related to a revised definition of the vertical deflection ratio.

Comparison with Previous Studies

- Washington DC metro
 - ◆ ground conditions include alluvial soils
- Recent projects in London
- Sao Paulo metro
 - ◆ Stiff clays.



Fare Integration Plan for *Públicos* and Tren Urbano

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Introduction



The integration of fare technology will facilitate the expected number of transfers that will occur when Tren Urbano is operational.

Públicos are the largest provider of transit trips in the metropolitan area and as a result they must be included in any fare integration plan.

New fare media technology, consisting of contactless smart cards could be an option for fare integration between *Públicos* and Tren Urbano.

5th UPR/MIT *Tren Urbano* Meeting

January 7 - 15, 1999



Problem Statement



Públicos are a significant challenge in terms of fare integration because of the nature of the system: profit oriented, non-subsidized, owner-operated, and loosely regulated.

Públicos operate on a cash only fare system and the money collected is the owner's only source of income.

Públicos are strongly resistant to change the fare collection because they do not trust the new system will protect their profit.

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Objectives



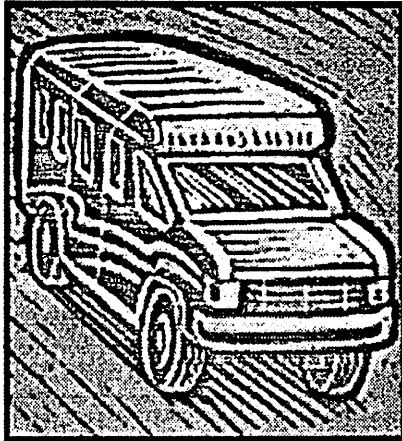
- ✓ To study the institutional, technological, financial and acceptance issues that make *Públicos* a significant challenge in terms of fare integration.
- ✓ To develop an implementation plan for contactless smart cards on the *Públicos*.
- ✓ To address the challenge in an efficient way that will satisfy the operators and the transit provider.

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Público System



The Público system is a privately operated government regulated transportation service to the general public.

Characteristics

- ✓ fixed route
- ✓ semi-scheduled
- ✓ non-subsidized
- ✓ owner operated
- ✓ cash-based fare

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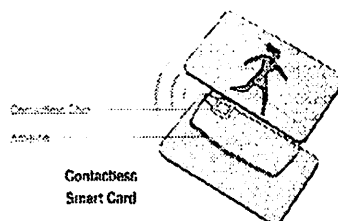
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Contactless Smart Cards



Contactless smart cards are stored value cards with a computer chip inside that deducts the fare value when passed closed to a reader unit using radio communication.



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Work Plan



August to December:

- ✓ Investigate the actual plans to integrate *Públicos* by Multisystems, HTA, PSC and GMAEC.
- ✓ Interview experts in order to familiarize myself with the problem.
- ✓ Review of the Law No. 4 (1952) which currently regulates the *Públicos* operation.
- ✓ Meeting with Banco Popular about the possible implementation of smart cards, and their involvement when Tren Urbano operates.

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Summary of Findings



Institutional Issues

Públicos are individual entrepreneurs and more than 1000 in the metropolitan area, thus all will not agree in fare integration.

Público's integration with other modes need to be resolved before the integration of fares is achieved for it to be effective.

The Public Service Commission, agency that regulates *Públicos*, has not an active part in the actual integration plans for them.

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Summary of Findings



Technological Issues

Contactless smart cards are a technology not proven yet, and without a business case it is still uncertain if it will be an asset.

A multi-application card is best. It can be use in transit and other services but the implementation is even more complicated.

Revenue allocation process needs to distribute the daily income to *Público* drivers the same day.

Security of cards is still an issue because concerns exist about the privacy of this technology.

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Summary of Findings



Financial Issues

Smart cards costs are expensive, \$5 each, and stand-alone readers cost \$2000. *Públicos* cannot afford these prices.

Federal funds can be used but *Públicos* need to comply regulations like ADA and no-private use and they don't.

TU will have to afford the transfer discount amount, if any, in order for *Públicos* keep receiving their complete fare.

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Summary of Findings



Acceptance Issues

Operator's primary fear is that government will have earning data since they normally do not report their income.

Públicos do not believe TU will increase their ridership.

Users need to embrace this technology but many do not trust the idea of money stored in cards, they use cash all times.

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Preliminary Conclusions



Intermodal integration including *Públicos*, needs to be achieved before any fare integration plan is implemented.

The options of "do-nothing" or a totally new system exist, however, the *Públicos* still need to integrate.

Smart card technology is almost unknown in Puerto Rico and very few know about its benefits in transit.

An intermodal integration plan that includes funding, equipment, and revenue allocation may lead to an effective fare integration plan.

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Preliminary Conclusions



Smart cards will be a feasible fare media in the future when technology become more available.

Banks are studying the implementation of chip cards in the near future. Three banks in Caguas will begin a trial program in February.

The timing for the fare integration discussion is perfect because TU and the HTA are developing preliminary programs aimed to full integration of modes.

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Future Work Plan



Investigate how TEA-21st and "*Banco de Desarrollo Económico*" could assist financially the *Públicos*.

Study the implementation of a chip card in three banks in Caguas and the impact of this technology.

Analyze the recommendations Multisystems will present to the HTA about initial integration plans for *Públicos*.

Develop final recommendations for an effective fare integration plan considering the institutional, technological, financial and acceptance issues.

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Future Work Plan



Continue investigating the possible local service providers, specially banks, if a multi-application card is used.

Keep reviewing advances in smart card technology that will facilitate fare integration plans.

Analyze the impact of other contactless smart cards programs underway in US cities like Chicago, Washington, D.C., and Seattle.

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January 7 - 15, 1999



Acknowledgments



Mrs. Freya Toledo - Planning, HTA
Plan. Gabriel Rodríguez- Planning, HTA
Mr. Jorge Hernández - Banco Popular
Mr. Horacio Tous - Banco Popular
Mr. Randy Altshuler - Tren Urbano
Mr. Jeff Squires - Tren Urbano
Mrs. Erika Columna - Planning, PSC

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Análisis de mapas de transportación y propuesta

**Miguel E. Vicéns
Tanya Román Román
Escuela de Arquitectura de P.R.**

Resumen

- Por medio de nuestra experiencia personal, hemos notado que los mapas de ruta desarrollados en distintos lugares no son fáciles de interpretar debido a:
 - escasez de información
 - simbología utilizada
 - complejidad
- Estos factores nos motivaron a basar esta investigación en el estudio de los mapas del sistema con la intención de diseñar un mapa de ruta que satisfaga las necesidades del público en general.

Introducción

- El propósito de esta investigación es:
 - Estudiar los mapas del sistema de transportación que se le otorgan al público como medio de orientación.
 - Mostrar distintos mapas de transportación como el mapa general de la ruta del tren urbano, mapa actual de la AMA y mapas de rutas del tren de otras ciudades.
 - Recoger la opinión de las personas, con respecto a estos mapas, a través de una encuesta.

Objetivos

- Tomando en consideración las necesidades y grado de entendimiento de las personas en P.R., diseñar el mapa de ruta del tren que será utilizado como mapa del sistema en las estaciones y como mapa portátil.
- Diseñar un mapa que sea fácil de entender, claro, preciso y a la vez, que su expresión gráfica sea del agrado de los usuarios.

Tipos de Mapa

- Mapa del Sistema o General: Es el mapa que se coloca en las estaciones y en el que se define la ruta del tren, las estaciones y otra información adicional como facilidades de estacionamientos, guaguas, minusválidos, entre otros. Se coloca el mismo mapa en todas las estaciones.
- Mapa de Localización: Es el mapa que se coloca en cada estación en el que se definen los alrededores de la estación (carreteras, negocios, etc.).

Tipos de Mapa (Cont.)

- **Mapa Portátil:** Es un mapa del sistema a una menor escala. Los usuarios lo llevarán consigo para utilizarlo en cualquier momento. En el folleto o tarjeta donde se presenta dicho mapa, se incluye información adicional como lugares turísticos, propagandas, horarios de paradas y otros.

Mapa General: Fase I

- El mapa general de la ruta del tren urbano para la Fase I aún no se ha diseñado de forma que al público se le haga fácil de entender.
- El mapa no contiene suficiente información para conocimiento público.
- Con los resultados de una encuesta realizada, decidimos desarrollar un mapa sencillo con información relevante de cada estación.

Encuesta Realizada

- La encuesta realizada recoge la opinión de personas, tanto del Area Urbana como del Area Suburbana de la Isla.
- Inicialmente, se mostraron distintos mapas como: Mapa del Sistema del Tren Urbano, Mapa Lineal del Tren Urbano, Mapa de la AMA (1999) y Mapa de Boston.
- El propósito de dicha encuesta es estudiar el grado de entendimiento de las personas al enfrentarse con diferentes mapas de transportación.

Resultados

- La mayor parte de las personas:
 - Nunca han utilizado un tren como medio de transportación pública.
 - No entendieron los símbolos presentados en el mapa del sistema.
 - No entendieron los mapas de la AMA.

Conclusiones

- La mayor parte de las personas en P.R. no están educadas acerca de un sistema de mapas de transportación.
- Los mapas que se han diseñado no ofrecen información clara al público.
- El mapa mejorado ofrece información más clara y completa.
- Se añadió información como facilidades de guaguas de la AMA, autos públicos, ruta del aqua expreso, estacionamientos, hospitales, facilidades para minusválidos, ciudades históricas, coliseos y parques.
- Se escogieron símbolos fáciles de entender y que de alguna manera se relacionaran con lo que representan.
- Se incluyó una leyenda para facilitar la interpretación de los símbolos, a pesar de que hay muchos que se entienden por sí solos.

Trabajo Futuro

- Continuar la elaboración del diseño del mapa del sistema.
- Diseñar el mapa portátil y proponer qué información adicional se podrá incluir adjunto.
- Diseñar los mapas de localización de las estaciones.

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Reconocimientos

- Arq. Esteban Sennyey
- Sra. Lydia Mercado
- Arq. Fernando A. Rojas
- Arq. Américo González
- Sr. Hiram Matos
- Sr. Rafael Marrero

A todos ellos le extendemos nuestro más sincero agradecimiento por su ayuda incondicional y disponibilidad en todo momento que les necesitamos para hacer posible esta investigación.



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Recinto de Río Piedras



PROYECTO DE PLANIFICACION QUE INCORPORA MECANISMOS FISCALES Y ESQUEMAS FINANCIEROS PARA DARLE UN USO EFICIENTE A LOS TERRENOS ALEDAÑOS A LA ESTACION DE BAYAMON, TREN URBANO

MISION

Darle un uso eficiente a los terrenos aledaños a la estación de Bayamón a través de la implantación de esquemas financieros y mecanismos fiscales que incorporen las fuerzas dominantes del mercado.

5 OBJETIVOS

- o Investigar los principios (teorías), fuerza y factores que dan forma al ordenamiento del espacio territorial
- o Analizar el impacto que pueda tener la estación de Bayamón sobre los usos y la valorización de los terrenos bajo su influencia, y cómo este proceso alterará el uso de los mismos
- o Estudiar los instrumentos fiscales y esquemas financieros que se puedan implantar en el caso de estudio
- o Estudiar ejemplos de otros países que integren los usos de transporte colectivo como método para mejorar la calidad del espacio territorial
- o Diseñar escenarios futuros (alternativas) sobre los terrenos aledaños a la estación del Tren Urbano, estación de Bayamón

Síntesis de El Problema

El problema es la falta de mecanismos que incorporen el funcionamiento de las fuerzas dominantes del mercado para disminuir la tendencia del desparramamiento urbano y para guardar por la calidad del espacio.

Project relation to the case study area

Bayamón's urban spatial structure serves as an example of similar situations that occur in many urban areas of Puerto Rico. Some of the most present characteristics are:

- Fast paced construction tendencies within a very limited geographical space
- Intensive construction of highways and expressways
- Proliferation of fragmented market centers
- Lack of consensus and unity for the urban structure
- Market centers that not necessarily maintain an amiable environment for the consumer of the retailer
- Repeatedly flooding
- Destruction of the natural ecological systems
- Changes within the local economy: small business are pushed to bankruptcies as they are challenged by the appearance of mega stores
- Reduction on the air humidity
- Destruction of the green urban areas
- Air pollution
- Deterioration on quality life
- Deterioration on citizen security
- Deterioration on economic health of the traditional urban centers



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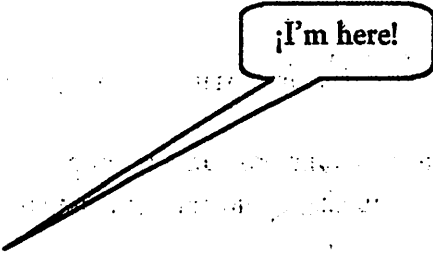
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Project Map

- I.** Title
- II.** Introduction
- III.** Justification
- IV.** Mission/Vision
- V.** Description of the problem
- VI.** Theories
 - Central Location Theory
 - Transportation Theory
 - Rent Theory
 - Valorization Theory
 - Gravity Models
- VII.** Hard and soft data gathering
- VIII.** What do I mean by efficient urban spatial structure?
- IX.** How does the fiscal and financial mechanisms work in relation to urban sprawl?
- X.** Historic cases where fiscal and/or financial mechanisms have been implemented
- XI.** Scenarios/alternatives
- XII.** Project implementation plan
- XIII.** Conclusion



I'm here!

Bibliography

El Problema

Puerto Rico tiene un espacio territorial muy limitado. La tendencia de la construcción urbana es alcista y acelerada. Incluso, la construcción intensiva de sistemas viales (de transporte individual), hace que los nuevos centros de mercadeo sean parte de un sistema espacial urbano altamente integrado. Como consecuencia, la urbe se compone de pequeños centros fragmentados y desordenados, y crece descontrolada y desparramadamente sin guardar por la calidad del espacio. Se sacrifica el ordenamiento racional por el desarrollo y la expansión desparramada. Se construye sin una meta o concepción del espacio articulada y definida. Los centros de mercadeo acomodan actividades al azar, sin necesariamente diseñar una organización del espacio agradable para el comerciante ni para el consumidor.

Una buena organización del espacio urbano tiene la capacidad de contribuir al bienestar y a la calidad de vida del ciudadano. Por una buena organización del espacio urbano me refiero a mejoras en la calidad del espacio tanto público como privado. Las mejoras pueden incluir paseos peatonales, actividades económicas productivas, parques, centros cívicos, actividades culturales, etc.

Por otro lado, se identifican unos cambios tanto en la economía mundial como local. La economía mundial evidencia cambios hacia una producción basada en la prestación de servicios (terciarización de la economía); la actividad productiva no requiere de una amplia localización, pero sí de una buena infraestructura apta para las telecomunicaciones y divulgación de la información y conocimiento.

La economía local evidencia cambios en el comercio, entre otros; los pequeños negocios se ven amenazados por la aparición de mega tiendas como lo son *Walmart*, *Builder's Square* (*Masó*), *Marshall*, etc. Por exigir locales de sobre 100,000², estas mega tiendas deben ubicarse fuera de los centros urbanos. Como consecuencia se crean nuevos centros de mercadeo que diluyen las fuerzas de los poderes adquisitivos de los ciudadanos; menguan los recursos municipales en la medida que se dispersan nuevas comunidades y no disponen de suficientes recursos para atender las áreas centrales; se invita a, y prolifera la construcción de proyectos de baja densidad y unidades individuales cercanos a las nuevas mega tiendas. Además, con la construcción intensa de carreteras, se acortan las distancias; esto implica un elemento de subsidio por parte del sector público en la medida que se provee infraestructura que propicia la suburbanización. Si en adición, los terrenos de la suburbia tienen un valor inferior comparados a los terrenos en el área central, se invita a la compra de terrenos suburbanos. El comprador está dispuesto a apartarse del centro; favorece la compra de mayor espacio a mayor distancia. Consecuentemente, comienza un proceso de deterioro en la vida económica de los cascos de los municipios, como pasa en Mayagüez, Arecibo, y Ponce, entre tantos otros.

Las acciones colectivas del sector privado, relacionadas a los usos de los terrenos, pueden tener resultados detrimentales para el bienestar público; se atenta, contra la calidad de vida. Por ejemplo, la construcción desarticulada tanto de viviendas como de comercios es en cierta medida, causante de inundaciones repentinas en los centros urbanos, destrucción de sistemas ecológicos naturales (zonas cársicas, coñteras y boscosas), destrucción de áreas verdes urbanas, alza en temperaturas en los centros urbanos, reducción en la humedad del

Project relation to the case study area

Bayamón's urban spatial structure serves as an example of similar situations that occur in many urban areas of Puerto Rico. Some of the most present characteristics are:

- Fast paced construction tendencies within a very limited geographical space
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aire, contaminación sonora, contaminación del aire, deterioro en la seguridad civil, deterioro en la salud económica de los centros tradicionales rampante, pérdida de suelo fértil apto para la producción agrícola. Para defender y proteger el bienestar público, el estado guarda la prerrogativa de intervenir a través de reglamentos y regulaciones de carácter físico y fiscal.

En este momento, considero se necesitan cambios por parte del sector privado en cuanto a los usos que se le dan a los terrenos en Puerto Rico. Los mecanismos de zonificación, densificación y consolidación de los centros urbanos, utilizados hasta ahora para evitar el desparramamiento en Puerto Rico no han tenido éxito; no incorporan el funcionamiento de las fuerzas dominantes del mercado, las cuales actualmente subsidian el desparramamiento. El mecanismo del mercado no funciona muy bien en la asignación óptima de los usos de los terrenos. Por lo tanto, existe la necesidad de desarrollar e implantar otros mecanismos, quizás de índole fiscal y financiera, que utilicen la lógica del mercado para obtener una mejor organización del espacio urbano.

Las fuerzas sociales, económicas, políticas y ambientales que le dan forma al ordenamiento territorial se deben canalizar por dos razones. Primero, para que los resultados sean socialmente deseables, sin menoscabar el bienestar económico y la sustentabilidad del ambiente natural; y segundo, para que permita racionalizar el manejo y el costo de los suelos.

Delimitación del caso de estudio

Tengo interés especial en el impacto que puedan tener las estaciones del Tren Urbano sobre los usos y la valorización de los terrenos bajo su influencia, y cómo este proceso alterará el uso de los mismos. Deseo utilizar, como caso de estudio, los terrenos aledaños a la estación de Bayamón. El sistema de transporte colectivo representa un proyecto que podría contribuir a mejorar el espacio territorial urbano. Además, estudiar el impacto del proyecto del Tren Urbano sobre los usos y la valorización de los terrenos, brinda la oportunidad de investigar sobre la posibilidad de implantar instrumentos fiscales y esquemas financieros para darle un uso racional y sustentable a los terrenos en Puerto Rico.

At this moment in time, I feel the need for change in the patterns of behavior of the land market. Previously used mechanisms such as zoning, densification and consolidation of the urban centers have not been successful in deterring urban sprawl. These mechanisms do not incorporate the tendencies of the land market, which currently subsidize urban sprawl. Consequently, other types of mechanisms, fiscal and/or financial, might have to be implemented. These tools do comply with land market tendencies.

Defining the case study

I have particular interest in the impact that the Tren Urbano's Stations will have over the uses and valorization of the land under their influence. I would like to use, as my case study, the land around Bayamón Station. The implementation of a major transits system, such as Tren Urbano, represents an opportunity to improve the urban spatial structure. Also, the study of the impact of the Tren Urbano over the uses and valorization of the land brings about the possibility to research on financial and fiscal mechanisms that might help control or deter urban sprawl.

Pertinencia del proyecto al área de investigación

La situación del área de Bayamón ejemplariza circunstancias similares a las que ocurren en diversos centros urbanos del resto del país. Las características predominantes son:

- Tendencia alcista y acelerada de la construcción urbana en un espacio territorial muy limitado
- Construcción intensiva de sistemas viales
- Centro de mercadeo que es parte de un sistema espacial urbano altamente integrado
- Urbe compuesta de pequeños centros fragmentados y desordenados
- Crecimiento descontrolado y desparramado de la urbe sin una meta articulada y definida
- Se sacrifica el ordenamiento eficiente por el desarrollo y la expansión desparramada
- Centro de mercadeo que no necesariamente mantiene un espacio agradable ni para el comerciante ni para el consumidor
- Inundaciones repentinas en el centro urbano
- Destrucción de sistemas ecológicos naturales
- Cambios en el comercio: pequeños negocios se ven amenazados por la aparición de mega tiendas
- Reducción en la humedad del aire
- Destrucción de áreas verdes urbanas
- Contaminación sonora, y de la pureza del aire
- Deterioro en la calidad de vida
- Deterioro en la seguridad civil
- Deterioro en la salud económica de los centros tradicionales

The Problem

Puerto Rico has a very limited territorial space. Urban construction grows at a fast rate. Specifically, but not exclusively, the intensive construction of highways and expressways facilitate the creation of new market (trading centers) centers. As a consequence, the urban area is composed of small fragmented and disordered centers, provoking urban sprawl, which does not allow a sustainable quality of urban spatial structure.

Construction advances without a macro urban goal. The new market centers accommodate random economic activities without necessarily compromising with an amiable environment for the consumer or the retailer.

A good urban spatial structure has the ability to improve the wellbeing and the quality of life of the citizens. By a "good urban structure" I mean improvements in both public and private urban space. Improvements could include boulevards, productive economic activities, parks, civic centers, cultural activities, etc.

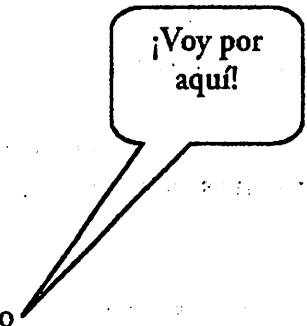
On the other hand, one can identify changes within local and global economy. Briefly, the global economy is witnessing changes towards production based on services; no longer production based activities require vast amounts on land and/or physical structures. It requires good efficient infrastructure apt, for example, for telecommunications or for divulgence of information and knowledge.

On the contrary, the local economy witnesses changes in its commerce (retailers): small businesses are challenged by the acute increase of mega stores located outside of the urban fringe. These mega stores require over 100,000 of physical structure. As a consequence of their establishments, new market centers are created outside of the urban fringe, which in turn could dilute citizen acquisition owner; reduce the municipalities' resources to healthily sustain their urban centers; and spur the construction of new low density neighborhoods. Also, the intense and continuous construction of highways and expressways help shorten distances, implying a direct subsidy factor (sponsored by a public agency) for urban sprawl. In addition, the valorization of the land located on the outskirts of the urban fringe is based upon a 1941 assessment, which is much lower than the assessment for the land within the urban fringe. This situation encourages develops to buy outside the urban fringe, inducing urban sprawl. Consequently municipalities experience economic deterioration of their centers, as it is presently happening at many municipalities such as Mayagüez, Arecibo, Ponce, San Germán, etc.

The summation of the actions of the private sector, related to the different uses of the land, could provoke detrimental consequences to the population wellbeing; it negatively challenges the quality of life. For example, the continuous tendency of construction all over the Island causes, in high degree, floodings, erosion of the topsoil, destruction on natural ecological systems, destruction of green urban areas, increase in temperatures within the urban centers, reduction of air humidity, air pollution, deterioration of citizen security, deterioration of economic health within the traditional urban centers. To conserve and preserve the wellbeing of the citizens, the government has the power to intervene if necessary.

Mapa del proyecto

- I.** Título
- II.** Introducción
- III.** Justificación
- IV.** Misión/Visión
- V.** Descripción del problema
- VI.** Marco Teórico
 - “Central Location Theory”
 - Transportation Theory”
 - Rent Theory
 - Valorization Theory
 - Gravity Models
- VII.** Recopilación de datos del área de estudio
- VIII.** ¿Qué es uso eficiente del espacio territorial urbano?
- IX.** ¿Cómo funcionan los instrumentos fiscales y financieros en relación al deparrramamiento urbano?
- X.** Casos históricos donde se hayan implantado instrumentos financieros y/o fiscales
- XI.** Escenarios/alternativas
- XII.** Plan para la implantación del proyecto
- XIII.** Conclusión



¡Voy por aquí!

Bibliografía



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PLANNING PROYECT WHICH ADOPTS FISCAL AND FINANCIAL MECHANISMS TO EFFICIENTLY USE OF THE LAND CIRCUMVALATING BAYAMON STATION, TREN URBANO

MISSION

To efficiently use the land circumvalating Bayamón Station through the implementation of fiscal and financial mechanisms which comply with the land market tendencies.

5 OBJETIVES

- o To investigate the theories, tendencies y factors which influence the urban spatial structure
- o To analyze the possible impact the Bayamón station might have over the use and valorization of the land under its influence
- o To study possible fiscal and financial mechanisms which can be implemented to rehabilitate and densify trading (market) centers.
- o To study examples from other countries which use transit systems similar to Tren Urbano as a tool to improve urban spatial structure
- o To design future scenarios (alternatives) concerning the land around Bayamón Station

Synthesis of The Problem

The problem is the lack of mechanisms which comply with the land market tendencies to deter urban sprawl and to preserve the quality of urban spatial structure.