Environmental Innovation and Management in Curitiba, Brazil

Jonas Rabinovitch with Josef Leitmann

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URBAN MANAGEMENT AND THE ENVIRONMENT

ENVIRONMENTAL INNOVATION AND MANAGEMENT IN CURITIBA, BRAZIL

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FOREWORD

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The working paper series has several objectives. The **content** of the series will seek to highlight examples of good and best practice in the various components of urban management. This will range from case studies of one or more aspects of urban management in a particular city to regional and even global syntheses of experiences. Much of the latter will increasingly be drawn from the UMP's regional programs. The **timeliness** of the information in the series is an important objective. Hence, the review and production processes for issuing the series have been streamlined to allow for rapid publication and dissemination. The **sources** of material that will be published in the series are intended to be diverse. Authors will be drawn from the UMP regional coordinators, Programme consultants, members of the UMP's regional networks, UMP nucleus team members, and others. The **audience** for the working papers will also be diverse, varying according to publication. The series should be of use to urban managers, urban policy makers at different levels of government, ESAs that provide support for urban development, community and nongovernmental organizations, academics, and the media.

In parallel, the UMP also issues a formal publications series that consists of discussion papers, policy framework papers, and management tools. A list of titles that have been prepared in the formal series is attached at the end of this paper. Many of the formal series publications are available in English, Spanish, and French. The working paper series is available only in English though translations could be available at a later date.

ACKNOWLEDGMENTS

INTRODUCTION

The experience of Curitiba has been recognized by the international media, experts, and development institutions as a successful example of urban environmental management. Because of this status, the city of Curitiba was chosen as a showcase to host the World Urban Forum, a meeting of mayors, other city officials, and urban experts, prior to the 1992 United Nations Conference on Environment and Development (UNCED). Little comprehensive information has been available about the range of Curitiba's environmental innovations, how they are managed, and how they have evolved over time.

This paper encompasses the period between 1965 and 1992 and concentrates on the **solutions** developed as a result of an explicit urban planning process. There is no intention to depict Curitiba as a utopia; the city has had and still has a variety of urban-related problems, like any other city in the world. It is hoped, however, that this presentation of the main difficulties, innovations, principles, and results achieved in Curitiba can serve as a basis for discussion and guidance for other cities. The views expressed here are those of the authors and do not necessarily reflect the views of the Curitiba city administration, the World Bank, the United Nations Centre for Human Settlements, the United Nations Development Programme, or the Urban Management Programme.

ABBREVIATIONS

CIC	Curitiba Industrial City
COHAB-CT	Curitiba Housing Company
FCC	Cultural Foundation of Curitiba
IBGE	Brazilian Institute of Geographical Statistics
IPPUC	Curitiba Research and Urban Planning Institute
PMC	Curitiba City Hall
SANEPAR	Sanitation Company of Parana State
SMMA	Curitiba Environment Department
SUREHMA	Environmental Agency of Parana State
UMP	UNDP/UNCHS (Habitat)/World Bank Urban Management Programme
UMP/E	Environment component of the UMP
UNDP	United Nations Development Programme
UNCHS	United Nations Centre for Human Settlements, Habitat
URBS	Urbanizacao de Curitiba (a parastatal company)

EXECUTIVE SUMMARY

Curitiba is a southern Brazilian city of 1.6 million inhabitants (metropolitan population: 2.3 million). From the 1950s through 1980, it has been Brazil's fastest growing city; its poverty profile and rate of inflation have been similar to other cities in the south and southeast of the country. Curitiba has not only prospered economically but has done so in an environmentally sensitive manner, despite the pressures created by rapid growth, inflation, and poverty. Beginning in the 1960s, most Brazilian cities built highways and consolidated the predominance of the automobile; Curitiba took a different path. This working paper examines how that path was laid out, where it led to, and what was learned along the way. It begins with background information on the city in Chapter 1.

Pathfinding and Planning

Curitiba, like many other cities around the world, developed a master plan in the 1960s. Unlike other cities, the central guidance given in the plan was adhered to over a period of more than twenty years. Two key principles of the plan were:

- modifying urban growth from a radial to a linear pattern by integrating the road network, public transportation, and land use; and

- decongesting the central city and preserving its historic center.

The new path was not built and followed overnight. After six years of research, institution building, human resource development, and consensus-building in the pre-implementation phase, the necessary political commitment for implementation materialized. Perhaps most important, it took the vision and leadership of a progressive mayor to begin the journey along a new route, followed by continuous political commitment of successive regimes to stay on course. The key features of Curitiba's planning process are summarized in Chapter 2.

New Directions: Innovations in Urban
Environmental Management

During the 1970s, the city began to implement an urban design that emphasized linear growth along structural axes that were planned and implemented to reinforce public transportation networks. Simultaneously, the public transportation system was realigned and expanded to bolster and make use of the structural axes. Land use legislation was enacted at the same time to reinforce the spatial transition. The result is that, while Curitiba has over 500,000 cars (more per capita than any other city in Brazil, except Brasilia), 75 percent of commuters travel by bus and there is little traffic congestion. Details about the integration, management, and environmental impact of roads, public transportation, and land use are presented in Chapter 3.

While this integrative spatial strategy has resulted in the most significant changes for the city, Curitiba has also successfully experimented with a number of other environmental innovations. Seventy percent of households participate in the recycling of municipal solid waste through one of several novel programs. During the last twenty years, green space per capita has increased one-hundredfold (from 0.5 m^2 to 50 m^2 per citizen), an increase that is all the more amazing given that it took place during a period of rapid population growth; at the same time, this expansion was explicitly designed to benefit the city's flood control program and its diverse ethnic groups. In the area of water and sanitation, water and park development policies are integrated and innovative sewage treatment is used to meet the needs of rapidly growing peri-urban areas. Industrial pollution control has been facilitated by the creation of the Curitiba Industrial City, an industrial park that attracts low-polluting enterprises. Ecology is integrated into many facets of Curitiba's progressive education system for children and adults. The characteristics of these and related initiatives are outlined in Chapter 4.

What is to be Learned?

Some of the lessons that Curitiba has to offer other cities in both the developing and industrialized world are:

- Even during a period of rapid demographic growth, physical expansion can be guided through integrated road planning, investment in public transportation, and enforcement of appropriate land use legislation.

- Technological solutions and standards for everything from public transit to recycling should be chosen on the basis of affordability.

- Priority should be given to public transportation and pedestrians over private automobiles.

- For a city to contribute to sustainable development, it must minimize resource use and maximize conservation.

- Integrated solutions can be implemented through partnerships between key actors. This often requires that the network of formal and informal economic relations be supported and not hindered by urban managers.

- Creativity can substitute for financial resources. There are ways for traditional sources of problems to be turned into resources.

- Public information and awareness are essential. The better citizens know their city, the better they treat it.

- Capacity and expertise to support innovation needs to be institutionalized to enhance guidance and stability over time.

These may seem like simple doses of common sense but they have rarely been applied to ailing cities around the world. Perhaps the missing ingredient is political commitment and continuity: Curitiba's leaders have pursued their common-sensical path for over two decades. Curitiba still has serious sanitation, education, and housing problems to tackle. The challenge now is to continue the successful policies and programs while applying these lessons to unresolved issues of urban development.

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1. THE CONTEXT

1.1 Urban Setting and Development

The city of Curitiba is located at 25° South and 49° West (see Figure 1.1). It borders the municipalities of Almirante Tamandare, Colombo, Piraquara, São Jose dos Pinhais, Mandirituba, Araucaria, and Campo Largo. The area of the city proper is 432 km² (approximately 35 km North-South and 20 km East-West). It is situated 87 km west of the Atlantic Ocean at an average altitude of 908m. The climate is subtropical with an average of 22°C during the warmer months (September-April) and 15°C during the colder months (May-August) with occasional frosts during the nights of June-July.

The region is characterized by rolling hills with plateaus to the north, south and southeast towards the Iguazu basin. A series of rivers and streams cross the region, including the Iguazu, Agua Verde, Bacacheri, Atuba, Passauna, Barigui, Juveve, Bigorilho, Ivo, Belem, Campo Santana, Campo Comprido, Vila Guaira, Capao Raso, Vila Formosa, Padilhas, Ponta Grossa, Boa Vista, Cercado, Pinheirinho, Prensa, and Moinho.

1.1.1 City history

During the 17th century the region where Curitiba is located was explored by pioneers from neighboring São Paulo state in search of indigenous peoples and precious metals. The first group of settlers established themselves next to the Atuba river at a place called Vilinha and then moved to the area where the central Tiradentes square stands today.

In 1693 Curitiba was classified by the Portuguese authorities as a *vila* (small town) and grew due to its strategic location between the Atuba and Belem rivers on the route of the *tropas* (horse caravans transporting goods) towards the south of the country. In 1842 the vila was officially declared a city and in 1854 received the title of capital of the state of Parana. By this time, the first inflow of immigrants (mostly Europeans) began to arrive. From then through the 1940s, the city enjoyed moderate

economic prosperity, riding a series of economic booms in *mate* (a kind of tea), wood, cattle, and coffee.

Curitiba became a key service center for new economic activities after World War II, largely because of its central location in relation to roads and railways. Rapid economic and demographic growth in the last few decades transformed the city into an important industrial and commercial nucleus as well as a center for processing agricultural goods that are exported via the Paranagua sea port.

1.1.2 Demographics

Through the 1940s, the population of Curitiba grew at a slow and stable pace. From the 1950s onwards, the population of the municipality reflected the economic trends described above and experienced a high annual growth rate. With migration linked to the mechanization of agriculture and the development of export crops in the state of Parana, the urban growth rate of Curitiba and its metropolitan region was almost 7 percent by the 1970s—the highest in the country. Table 1–1 illustrates demographic trends in the city, metropolitan area, and Parana state.

Table 1–1. Demographic trends—Curitiba, Metro. Region & Parana State

Year	Curitiba	Avg. population increase (percent per year)	Metro. region	Curitiba metro. region (percent)	Parana State	Curitiba/ Parana State (percent)	Metro. region/ Parana State (percent)
1940	140,656	–	202,956	69.30	1,236,276	11.25	16.42
1950	180,575	2.8	307,294	58.76	2,115,547	8.54	14.53
1960	361,309	10.0	510,539	70.77	4,277,763	8.45	11.93
1970	609,026	6.8	821,233	74.16	6,929,868	8.75	11.85
1980	1,024,975	6.8	1,440,626	71.15	7,629,392	13.43	18.88
1990	1,608,151	5.7	2,250,959	71.44	9,818,373	16.35	22.93

Source: IBGE–Brazilian Institute of Geographical Statistics: Census–1940-50,60,70,80,90; IPARDES/IPPUC: Projection for 1990..

Figure 1–1. Map of Curitiba and environs
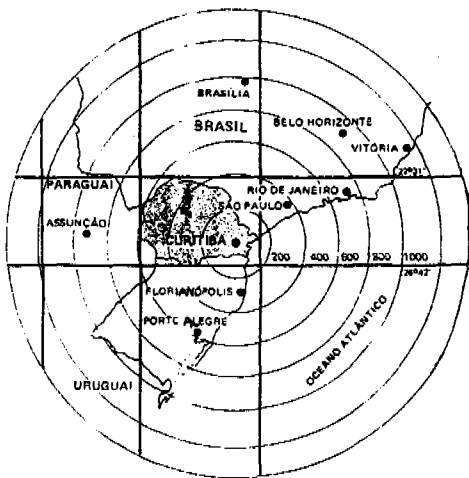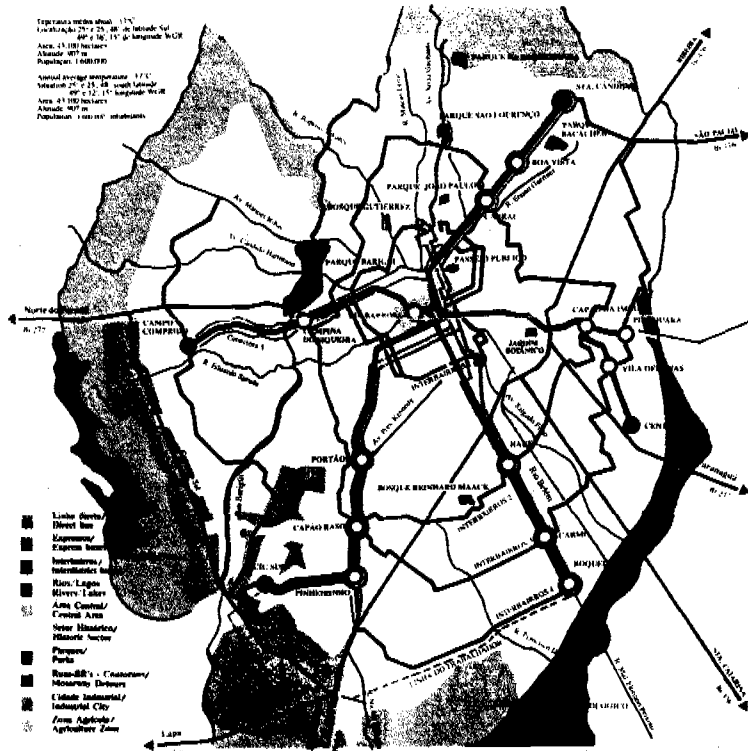
LOCATION OF CURITIBA

1.2. Socio-Economic Setting

1.2.1 Economic structure

The key economic activities in Curitiba are services, manufacturing, and commerce. Table 1–2 illustrates the number of people working in Curitiba by economic sector. The 1990 national census classified 8 percent of the economically active population in Curitiba as unemployed. However, Brazil does not have an unemployment compensation system and most low-income urban dwellers engage in temporary activities in the informal sector, making it difficult to measure actual levels of employment.

Historically, the transition from agricultural to industrial activities accelerated beginning in 1973 with the creation of the Curitiba Industrial City (CIC). The CIC occupies an area of approximately 40 km^2 on the western fringe of the city. It was created as a response to a policy of limiting further heavy and/or hazardous industrial activities within the borders of the municipality, and to attract more industries to a specific industrial area. As of 1991, 402 industries have located in the CIC: between 1973 and 1980, the area attracted 125 enterprises; between 1981 and 1990, an additional 277 firms moved to the Industrial City. Jobs generated by the CIC now account for one-fifth of the city's total employment.

Inflation is an important aspect of economic development in Brazilian cities. Table 1–3 indicates that Curitiba has experienced an average rate of inflation similar to that of other urban areas in the country over the 1980-90 period.

1.2.2 Income distribution and urban poverty

The economic welfare of the city of Curitiba is similar to that of other state capitals in the South/Southeast regions of Brazil.[1] Table 1–4 gives an

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1. This is particularly relevant to demonstrate the fact that the urban planning innovations developed in Curitiba did not succeed because of any economic advantage enjoyed by the city.

Table 1–2. Employment by economic sector

Economic sector	Employees	Share (percent)
Services	207,734	19.6
Manufacturing	201,497	18.9
Commerce	159,997	15.1
Social Services	105,492	9.9
Building Industry	88,682	8.4
Public Administration (All levels)	61,018	5.7
Agriculture	59,114	5.5
Economic Support Services	57,765	5.4
Transportation/Communications	56,684	5.3
Other Activities	49,084	4.6
Other Industrial Activities	14,915	1.5
Total	1,061,982	100.0

Source: IBGE, National Household Sample Survey, 1990

indication of the level and distribution of household incomes, based on a sample of 14,087 households in the 75 districts of the municipality, with figures for São Paulo and all of Brazil as comparators. The minimum wage is established by law and is supposed to determine the minimum monthly salary that any person over 18 years of age should earn in Brazil. This amount is occasionally raised by the central government to account for inflation. As an exampie, the value of one minimum wage in October 1992 was CR$ 522,000/month (US$72 per month at the then-current exchange rate).

The family and social structure of Brazil is characterized by large families and a considerable proportion of the population is under 18 years of age. In Curitiba this proportion is approximately 42 percent. Therefore, a household approach would be more realistic than a per capita analysis. A comparison between Curitiba and São Paulo indicates that Curitiba is not an exception in the social context of southern Brazilian cities, showing an average household income per year on the order of US$ 3,400. The nationwide figures are less useful as comparators because they capture the

30 percent of the population classified as rural, as well as the very poor, populous cities of the northeast of the country.

Referring to Tables 1–3 and 1–4, it is possible to conclude that a low-income family in Curitiba would have basically the same level of purchasing power as that of other low-income families in other Brazilian state capitals. Table 1–4 shows that 4.9 percent of Curitiba's households earn up to one minimum wage per month (US$72) and that another 28 percent earn between two and three minimum wages per month (US$125). The Curitiba Social Development Secretariat considers households in the former category as "in absolute poverty" and those in the latter category as "in priority need of attention". The difference between these families and those living in other Brazilian state capitals is not the condition of poverty in itself, but the level of services and the degree of participation in community activities offered to these families by the city.

Table 1–3. Evolution of the urban price index, 1980-90

City	1980	1985	1990
Belem	106.13	236.82	1,525.15
Belo Horizonte	90.86	235.23	2,116.89
Brasilia	98.98	229.13	1,610.89
Curitiba	92.97	238.82	1,794.84
Fortaleza	96.82	240.61	1,767.10
Porto Alegre	96.36	244.85	1,472.69
Recife	99.38	232.08	1,692.70
Rio de Janeiro	99.30	231.05	1,651.01
Salvador	92.38	244.32	1,737.10
São Paulo	90.31	235.17	1,849.85

Source: IPPUC, Curitiba em Dados, 1991.

Table 1–4. Income distribution—Curitiba, São Paulo, and Brazil

Number of minimum wages (monthly)	Curitiba (percent of households)	São Paulo (percent of households)	Brazil (percent of households)
1	4.9	4.4	18.0
2–3	28.1	29.9	38.5
4–5	25.7	17.6	18.4
6–10	25.6	27.2	14.1
11–20	11.4	13.6	6.8
21 +	4.3	7.0	4.0

Source: IPPUC household survey, 1990 (Curitiba); IBGE National Census, 1990
(São Paulo and Brazil)

2. ENVIRONMENTAL MANAGEMENT AND THE URBAN PLANNING PROCESS

2.1 Evolution of Urban Planning

The Agache Plan, designed by French urban planner Alfred Agache in 1943, was the first formal attempt to direct urban growth in Curitiba. The plan proposed a well-defined central area surrounded by residential zones with a traffic system composed of concentric (ring) roads linked to the central area by radial avenues, also known as the spoke-and-wheel design. The basic principle of the plan was to reinforce a central business district that would service the whole city through the system of access avenues. It reflected a classic planning concept and failed to predict the private automobile boom that occurred in Brazil during the 1950s. The plan was not implemented, except for the construction of radial avenues, mainly due to the lack of public funds at the time; this delay caused the city to grow beyond the physical limits envisaged by the Agache Plan.

The main legacy of the Agache Plan was consciousness-raising; it generated the perception that planning could help solve urban growth-related problems. This perception was acted on in 1964 when the public administration of Curitiba commissioned the "Preliminary Urban Plan" which later became the Curitiba Master Plan. Following a competition organized by City Hall and local professionals, this plan was developed by a consortium of Brazilian consulting firms. The Curitiba Research and Urban Planning Institute (IPPUC) was then created in 1965 to pursue implementation of the plan.

2.1.1 Key principles

The Curitiba Master Plan proposed not only a traffic management system, but also its integration with land use to limit the physical expansion of the central city. Commerce, services, and residences would expand linearly from the center through "structural axes." This plan had the following key principles:

- changing the radial urban growth trend to a linear one by integrating the road network, transportation, and land use;

- "decongestion" of the central area and preservation of the historic center;

- demographic control and management;

- economic support to urban development; and

- infrastructure improvement.

There is an important caveat concerning the first principle. This paper does not argue that linearly guided land development is a universal panacea for rapidly growing cities. Every city has a different set of physical constraints and opportunities. The case of Curitiba seems to demonstrate, however, that cities should make a conscious decision concerning their spatial structure in relation to patterns of travel and land use at the outset of rapid growth. It also demonstrates that linear growth can facilitate mass public transportation. Whereas some cities may have grown to the point where land use control policies are of limited value, there are many cities that have the opportunity to make the right decisions at the right time.

2.1.2 Styles of planning

There were two very distinct "styles" of the Curitiba planning process: a) the pre-implementation phase (1965–1970) characterized by the traditional master plan methodology and less emphasis on implementation, and b) the implementation phase (1971–present) characterized by the political will and the commitment of the public administration to "getting things done." This phase includes more than twenty years of work by different administrations with different priorities.

The first phase was important for the following reasons.

- It responded to social demands, articulated by a group of students, professionals, and public officials, to have an urban plan as basic guidance for the future growth of the city.

- With the creation of the Curitiba Research and Urban Planning Institute, IPPUC served as the "breeding ground" for many actors who later played key roles in the implementation phase. For example, future mayor Jaime Lerner was president of the IPPUC in 1968-69 and many other Institute officials were part of the first planning team.

- The lack of implementation between 1965–1970 gave the professionals at IPPUC breathing and thinking space to further develop the ideas contained in the plan; it could be seen as a "maturation" period.

The second phase was important for the following reasons: a) it allowed the city of Curitiba to implement its own solutions to the city's particular problems; b) it established in practice an urban planning tradition emphasizing implementation, with strategic coordination and guidance by the Planning Institute within the city administration; and c) it developed an approach to urban management based on the constant interplay between planning activities and implementation activities.

2.1.3 Consequences of the planning process

The document, "Curitiba 1971–1983–Inventario" (IPPUC,1983), suggests four specific transformations as a result of the planning process: physical, cultural, economic, and social. The **physical** transformation was characterized by urban growth guided by the following objectives.

- Incremental integration and development of the public transport system together with the land use legislation.

- Definition of priority physical works, without time-consuming surveys or theoretical debates.

- Development of a concrete policy to gradually improve infrastructure facilities following the above mentioned priorities.

The city administration then immediately implemented the first two structural axes with related infrastructure, a basic network of parks and public squares that could later be linked by cycleways, and a pedestrian network in the central area giving priority to people over cars. The beginning of the Curitiba Integrated Transport Network was also gradually implemented along the structural axes. Having implemented this basic structure, Curitiba could then implement other physical improvements.

The **cultural** transformation, according to the "Inventario," was a consequence of the physical transformation. The following changes occurred:

- revival of the city center as an important meeting place;

- preservation of historical buildings and cultural property;

- implementation of a "building recycling" policy giving new uses to old renovated buildings;

- creation of the Curitiba Historic District and the Curitiba Cultural Foundation;

- implementation of a series of works (cinemas, public squares, museums) that helped preserve cultural values and ethnic diversity in the Curitiba region; and

- inclusion of leisure activities and infrastructure in the new squares, parks, and low-income public housing developments.

The **economic** transformation was centered on implementation of the Curitiba Industrial City from 1973 onwards. The concept of the industrial city was not that of an isolated industrial ghetto but rather as industries surrounded by green open spaces, integrated with housing, transportation and services. Another important economic aspect was the implementation, from 1980, of *Nosso Programa* ("Our Program") that provided financial and other support to small-scale industries and informal activities.

The **social** transformation occurred mainly from the early 1980s onwards. Emphasis shifted from physical and economic priorities in the 1970s to meeting basic needs (education, housing, health, child care, and low-cost sanitation) in the following decade. The following social changes were pursued:

- improvements in the socio-economic distribution of infrastructure within the city;

- hierarchical service delivery with health centers and public schools, for example, built at the neighborhood level but linked to larger-scale units to form an integrated network;

- coordination between different government agencies to achieve integrated objectives;

- centralization of technical-administrative support and decentralization of implementation; and

- community participation.

The details and results of specific social programs will be presented in Chapter 4.

2.2 Key Actors

Over the period covered by this case study (1971-92), a number of actors have been involved with the Curitiba planning process. They can be divided into two basic categories: individual actors and institutional actors. The former have been as important as the latter and their interplay helps explain the success of the Curitiba experience. For example, the relationship of the individual actor, Mayor Jaime Lerner, with the institutional actors, City Hall and IPPUC, was part of the daily planning exercise in Curitiba.

2.2.1 Development of municipal institutions

The first administration of Mayor Lerner (1971–1974) was followed by the administration of Mayor Raiz (1975–1978), who followed his predecessor's priorities, though with more emphasis on public works. The key actors during the 1970s were mayors, private contractors, and municipal, state, and federal institutions. The mass media was under censorship and public participation was minimal throughout the country. Public involvement gradually increased after 1979 to a point where most programs in Curitiba now depend on popular participation. Mayor Lerner was elected again (1979–83), consolidating the current municipal institutional framework that is outlined in Box 2–1. This framework was consolidated and followed during the administrations of Mayors Fruet (1983-85), Requiao (1986-1988), and Lerner (1988-92).

2.2.2 Cross-jurisdictional relations

The relationship between the city of Curitiba and other levels of government also changed over time. In 1971, all mayors os state capitals were appointed by the state governors and there was a good, although dependent, working relationship between them. Although politically autonomous, cities were financially dependent on the state and federal governments. This dependency still exists, forcing Curitiba to learn to develop creative and self-financing programs and gradually implement its own ideas without outside help. Self-reliance was especially important when a political adversary of Curitiba's mayor became state governor in 1989. In addition, due to a national economic crisis, federal resources became scarce to the point that no ongoing program in Curitiba could continue to depend on federal funds. Thus, it became necessary to focus more frequently on appropriate technological choices and possibilities of direct technical support between cities.

As for federal relations, Brazil endured a military dictatorship from 1964 to 1979. The previous national import substitution policies were gradually replaced by a period in which foreign capital and influence favored large national infrastructure projects coupled with some increase in urban investment. Most Brazilian cities at the time used this situation to

build motorways and viaducts, thus consolidating the predominance of the private car. Curitiba, on the other hand, implemented its urban growth axes with dedicated express bus lanes and built its Industrial City. It was a time of physical change for the city as a whole.

Box 2–1. Curitiba's Municipal Institutions

The institutions within Curitiba City Hall are basically divided into direct and indirect administration. The direct administration is composed of the various Secretariats (Departments) within City Hall, sub-divided in the following way:

CENTRAL INSTITUTIONS
- Cabinet of the mayor
- Department of Municipal Government
- 5 Regional Administrations (maintenance)
- City Attorneys office
- Councils (disabled, elderly, substance abuse, women)

ADMINISTRATIVE INSTITUTIONS
- Administration Department
- Human Resources Department
- Social Communication Department (public information and relations)
- Finance Department

EXECUTIVE INSTITUTIONS
- Food Supply Department
- Urbanism Department
- Education Department
- Environment Department
- Children Department
- Public Works Department
- Public Works Department (by district)
- Road Network Conservation Department
- Health Department

The indirect administration is composed of the following:

PUBLIC INDEPENDENT INSTITUTIONS
(Autarquias)
- IPPUC (Curitiba Research and Urban Planning Institute)
- IMAP (Municipal Institute of Public Administration)
- IPMC (Municipal Institute for Social Assistance)

MIXED CAPITAL COMPANIES
- CIC (Curitiba Industrial City)
- COHAB-CT (Curitiba Housing Company)
- URBS (Urbanization of Curitiba)

FOUNDATIONS
- FCC (Cultural Foundation of Curitiba)
- FREI (Foundation for Education and Social Integration)
- FAS (Social Assistance Foundation)

One trend has been the increasing contact between municipalities, offering the possibility of a multiplier effect from technical interchange. Technical planning teams from Brazilian and foreign cities frequently visit Curitiba, and some of these teams actually began implementing similar projects in their cities. A few examples of ideas first developed in Curitiba which then spread to other Brazilian cities are segregated bus lanes, pedestrian streets, gradual development of land use legislation, several waste management programs, and integrated surface transport networks.

As far as metropolitan cross-jurisdictional relations are concerned, there are initial constraints should be considered. On the one hand, there has been a recognition in Brazil that some urban functions have important operational implications beyond municipal borders. On the other hand, municipalities have mayors from different political parties, and the relationship between them and with state governments have not always been characterized by cooperation.

To overcome these difficulties, institutions to coordinate cross-jurisdictional relations in the nine major metropolitan regions of Brazil were created in the mid-1970s. However, these institutions largely failed to bridge the gaps among mayors and between mayors and state governments. The experience of creating metropolitan coordination bodies in Brazil failed to establish a tradition of "metropolitan action." This failure occurred because mayors and governors did not wish to agree to what they interpreted as a partial restriction of their jurisdictional powers. Brazil has traditionally had three institutional levels—municipal, state and federal. The creation of a fourth (metropolitan) layer, although strategically necessary, did not have the necessary political support to be effective.

In the state of Parana, the COMEC (Coordination of the Curitiba Metropolitan Region) was no exception. Curitiba is the pole of a metropolitan region comprised of fourteen municipalities. With 1.6 million inhabitants, Curitiba contains more than twice the population of all other metropolitan municipalities combined. The demographic imbalance is paralleled by an economic one, as other municipalities

depend on the job market that exists in the state capital. Therefore, the management of public transportation, sanitation, waste disposal, and public safety crosses municipal administrative borders. Despite various coordination attempts from several sides, cross-jurisdictional policies have not been fully implemented at the metropolitan level. Still, with its demographic and economic weight, the city of Curitiba has managed to achieve a degree of coordination with specific neighboring municipalities to help solve specific problems. A few examples are new intermunicipal bus routes, acquisition of land for a new landfill, coordination for specific water and sanitation works, and public safety for certain areas.

2.3 Conclusion

The case of Curitiba demonstrates that, as important as it is to have an urban plan as guidance, it is equally important to develop an implementation strategy that guarantees concrete positive results. In Curitiba, the implementation strategy did not happen as a result of specific recommendations contained in the plan itself. The Curitiba Master Plan has been developed and implemented through IPPUC since 1965, with implementation initiated only in 1971 as a direct political decision of the first administration of Mayor Lerner. Thus, political will was essential to implementing the city's plans.

3. INTEGRATION OF ROADS, PUBLIC TRANSPORTATION AND LAND USE

3.1 The Road Network

3.1.1 Historical development

During the 1970s, city authorities began to implement an urban design structure that emphasized linear growth along structural axes (see Figure 3–1). Simultaneously, land use legislation was enacted to guide this growth. Curitiba's planned road network and public transport system are probably the most influential elements accounting for the present shape of the city.

Over the years, urban growth has been encouraged along five main axes with "structural" roads (see Figure 3–1). Each axis was designed as a "trinary" road system. The central road has two restricted bus lanes in the middle for express buses flanked by two local roads. On each side of this central road, one block away, are high capacity free-flowing one way roads, one for traffic flowing into the city, the other for traffic flowing out of the city. In the areas adjacent to each axis, land use legislation has encouraged high density occupation, together with services and commerce. The trinary system is graphically depicted in Figure 3–2

3.1.2 Integration of land use with the road system

Zoning. Curitiba is zoned so that land use follows two basic parameters: the kind of use (residential, commercial, industrial, mixed) and the density of development permitted. On the land sites located along the structural axes, legislation permits buildings to have a total floor area of up to six times the plot size (details of landuse legislation are provided in Annex 1). Developments close to other kinds of roads that are well served by public transport are also permitted to have relatively high coefficients—with floor space up to four times the plot size. This coefficient decreases the further a land site is from public transport. This has encouraged new commercial developments outside the central city, but along each structural axis, and high density residential developments so there is a match between high density residential and commercial areas

and the availability of public transport. Consequently, traffic has been eased in the central city, allowing downtown streets to be turned into pedestrian walkways. More information on land use is included in the last section of this chapter.

Land Acquisition. One important complementary activity to the road system was the municipal government's acquisition of land along or close to the new transport axes, prior to their construction. This permitted the government to build high density housing projects close to the transport axes. In all, housing for 17,000 lower-income families was built as one specific result of this strategy.

Road Planning. Another important element of Curitiba's road network is the concept and use of "road hierarchies." Each road is assigned a function in relation to its location and importance. There are the "structural" roads along the five axes described above and "priority" links that connect traffic to the structural roads. "Collector" streets have commercial activity along them with all forms of traffic, and the "connector" streets link the structural roads to the industrial city. These four types of roads form the skeleton structure of Curitiba.

3.2 Public Transportation

3.2.1 System development

Despite having some 500,000 cars (more per capita than any other major Brazilian city except Brasilia), Curitiba has minimal traffic problems. When the present transportation system was initiated in 1974, the city made a conscious decision to continue to develop a citywide transport system that relies entirely on buses. Curitiba's transportation system has evolved over the past twenty years; Box 3–1 highlights the key developments in the system over this period.

The decision to rely on buses rather than a more capital-intensive solution was based on the realization that the use of express buses on exclusive busways is far cheaper than subways or light rail, and represents a more flexible and affordable solution to public transport for a

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Box 3–1. Highlights in the Evolution of Curitiba's Public Transport System

1974: Implementation of the first two express bus lanes along the northern and southern structural axes.

1978: Three new express busways added along structural axes.

1978: Introduction of a new computerized area traffic control system.

1979: Introduction of the social fare: a standard fare paid by all bus users which benefits those who live on the city periphery (predominantly low-income groups) as shorter journeys subsidize longer ones.

1979: Introduction of interdistrict bus lines to complement the existing public transport system.

1982: Opening of a new connection between the city center and the industrial city and improvement of the interdistrict routes.

1991: Introduction of the Rapid Bus System (Direct Lines) using boarding tubes.

1992: Introduction of bi-articulated buses.

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medium-sized Third World city (see Box 3–2). Another comparative advantage of the surface bus system is that it can be planned and built to operate on the pre-existing street network (this is also generally true for light rail systems).

Along the main axes of the city, a central lane was set aside for buses only. New bus lines were created and expanded as the city grew. The sequence of drawings shows how a series of circular interdistrict bus routes developed since 1979, to complement the express busways. For the first time, a new mass transportation idea was created to meet the needs of a Brazilian city where the bus routes and land use were more important than the vehicle itself. Buses are color-coded: the express buses are red, interdistrict buses are green and the conventional (feeder) buses are yellow.

One of the key concepts in the transportation system is the ease with which people can transfer from local buses to the express buses and back to other local buses. There is full integration between express buses, interdistrict buses and conventional (feeder) buses. There are large bus terminals at the end of each of the five express busways (refer to Figure

Figure 3–1. Evolution of Curitiba's integrated transportation system, 1974–91
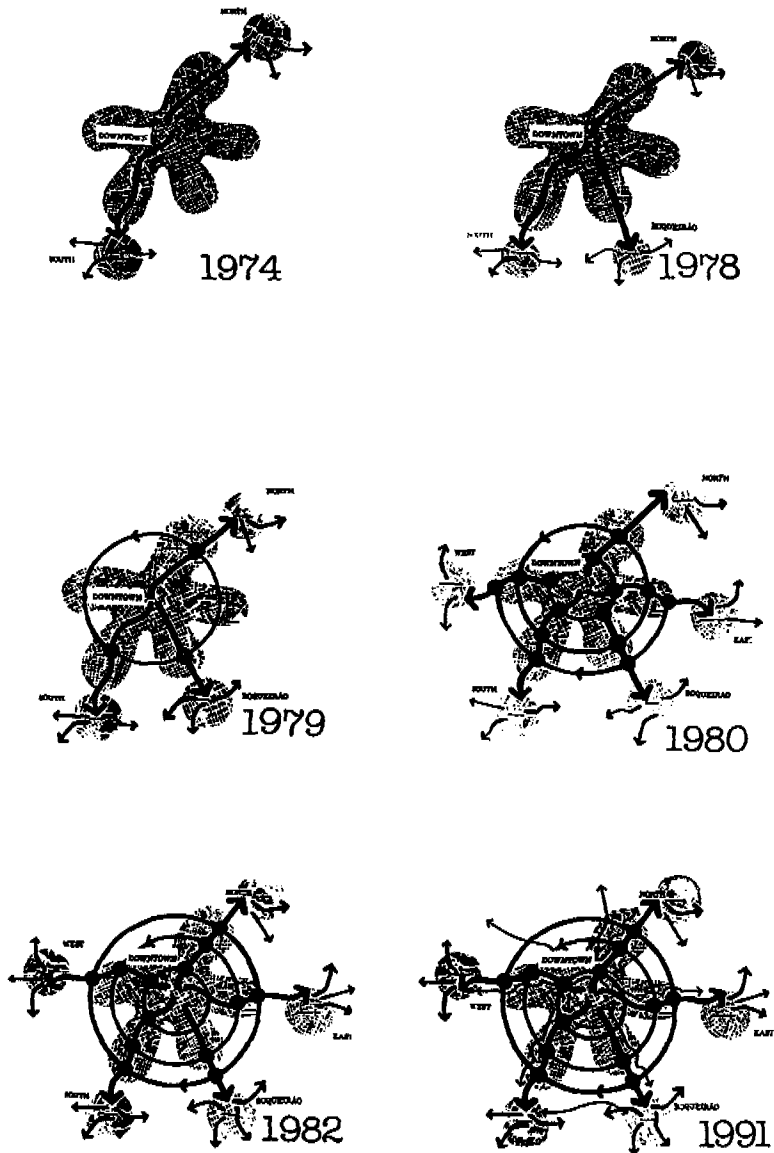
Figure 3–2. Trinary road system

Express Buses

Bus Terminal

Building Density
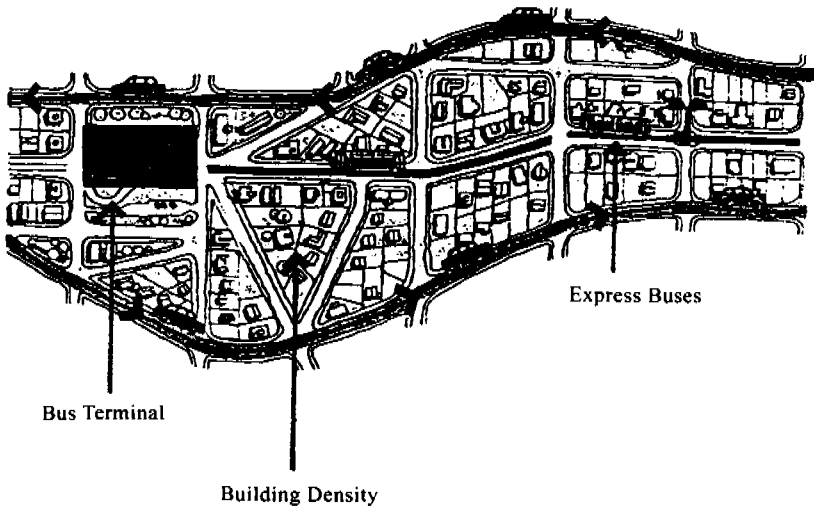
Source: IPPUC

3–1) where people can transfer to interdistrict, feeder or intermunicipal buses. One single fare is valid for all buses within Curitiba. Along each express route, medium-sized bus terminals are located approximately every two kilometers and are equipped with newspaper stands, public telephones, post offices, and small commercial facilities. Passengers arrive at these stations on feeder buses and transfer to the express or interdistrict buses. Riders can thus transfer from the red express buses (running along the structural axes) to yellow feeder buses (circulating through areas outside the central city), which take them to stations where they can transfer to green interdistrict buses that follow concentric routes linking outlying neighborhoods, all for one fare.

The latest innovation is the introduction of the "direct" express bus system that features fewer stops and where passengers pay before boarding the buses in special raised tubular stations. These run along the one-way routes on each side of the central roads that form the structural axes. The tubular boarding stations are platforms at the same height as the bus floors. They greatly reduce boarding and unloading times; a rapid bus system with these "boarding tubes" can take three times as many passengers per hour when compared to a conventional bus operating in a

normal street (see Table 3–1). The boarding tubes also eliminate the need for a crew on the bus to collect fares, which frees up space for more passengers. In this way, one of Curitiba's Direct (*Ligeirinho*) buses does the work of many traditional ones.

Since 1979 when interdistrict lines, a standard fare for the whole network, and new integrated terminals were introduced, a 514 kilometer bus network has developed. Automatic fare collection, articulated buses, and traffic lights that give priority to buses (operated by the vehicles themselves) help optimize the system's operation and result in lower operating costs. New initiatives are constantly being sought to improve the system. For example, a "bi-articulated" bus with a capacity for 270 passengers was introduced in 1992. These have five lateral doors for passenger entry or exit and are significantly decreasing boarding and unloading times, especially when linked to the new boarding tubes. These large vehicles were custom-built by Volvo's facility at the Curitiba Industrial City; 27 bi-articulated buses began operation in December 1992.

3.2.2 Management and Finance

The Curitiba Integrated Transport Network is managed by URBS (*Urbanizacao de Curitiba*), a parastatal company created by the city hall in 1963. Its responsibilities include calculation of bus timetables and frequencies, development of new bus routes, determination of the necessary number of buses, monitoring the performance of the system, training drivers and conductors, and responding to suggestions and complaints from the bus users. URBS also manages the Curitiba Taxi System, the municipal and interstate bus terminals, the public parking system in Curitiba, and community paving programs.

The bus system in Curitiba is operated by private companies, that receive licenses for specific routes and have to abide by regulations developed by URBS and IPPUC. The city pays the companies by the number of kilometers that they operate. The idea is simple: the daily revenue collected by each bus in Curitiba is immediately deposited in a bank account managed by URBS. The companies receive their revenue

Box 3–2. Relative Costs of Public Transportation Options	
Option	Capital Cost (US$/km)*
Underground metro system	90-100 million
Light railway system	20 million
Curitiba's Direct Route busway system (using boarding tubes)	0.2 million

* These do not include the economic costs related to construction of metros or light rail, or the
   capital costs of road building in the case of the bus system.

ten days afterwards, according to the number of kilometers that they have
run. A 1990 law establishes that the revenue collected by the city from the
bus system can only be used to pay for the system.

The main advantages of the payment-by-kilometer system are: the
quality of the service is regulated by the public sector whereas investment
originates with the private sector; the public sector can regulate the fare;
the financial risks for the private sector are minimized; and the calculation
and collection of the fares results in a transparent and easy way to monitor
the system.

Table 3–1. Capacity of bus options in Curitiba

Bus configuration	Capacity (passengers/hour)
Conventional bus on average street (80 passengers)	X
Conventional bus on busway (150) passengers)	2X
Double (Articulated bus) on busway (150 passengers)	2.5X
Direct Route with boarding tubes (110 passengers)	3.2X

Note: these figures are a simplification of operational data, taking into account the capacity of the
vehicles and their respective commercial running time.

Source: URBS, and interview with Mayor Lerner.

To ensure private sector accountability, URBS monitors the system according to two basic parameters: a) the number of passengers, based on daily readings of sealed turnstiles, and b) the number of kilometers based on the length of different routes, odometer readings, on-off surveys, and 24-hour bus garage doors surveillance. This supervision also helps URBS to calculate the bus fare. Curitiba uses a flat fare system that is technically determined by URBS. The calculation of the fare takes into account operational cost, administrative, and capital costs. The breakdown of these costs is presented in Box 3–3.

The flat fare of the Curitiba Bus System tends to vary between the equivalent of 20–25 US cents. It is one of the cheapest urban fares in Brazil considering that, at the price of one bus fare, the typical rider averages 2.4 transfers per day from one route to another at the integration terminals.

The monthly rate of return to the private bus companies is 1 percent of the capital invested in the bus fleet, which represents approximately 11 percent of the fare. Another component of the companies' profit is 3

Box 3–3. Costs Used in Bus Fare Calculation

1. Operational Costs

1.1 Dependent costs
- Fuel
- Lubricants
- Vehicle depreciation

1.2 Maintenance Costs
- Personnel
- Parts and accessories

1.3 Personnel Costs
- Drivers
- Conductors
- Supervisors
- Porters
- Uniforms

2. Administrative Costs
- Administrative personnel
- Administrative costs
- Equipments depreciation
- Payments for equipment/installations
- Payments for garage/repairs
- Depreciation of buildings/infrastructure

3. Capital Costs
- Payments to private capital (1 percent of investments in new buses per month
- Amortization of private capital (depreciation of the bus fleet)

Source: URBS

percent of administrative costs for equipment and infrastructure, representing 0.39 percent of the fare. The total return for bus companies is 11.39 percent of the fare.

Brazil has traditionally experienced high rates of inflation that, for example, averaged 25 percent a month in 1992. Even under these circumstances the bus system has been successfully operating. However, fares have to be constantly increased to cope with inflating operating costs. In reality, the new bus fares are a result not only of technical calculations but also of political negotiations. The bus companies naturally pressure to have fares increased as often as possible whereas riders demand constant or lower fares. City hall and URBS have to contend with the interplay of these two political forces and arrive at negotiated bus fare increases that are affordable to the public and profitable for the private sector.

3.3 Land Use

Curitiba's land use policy is based on legislatively designated special areas that merit integration with the transportation system or require special protection. These areas are geographically bounded by roads, zones within a district, or by a whole district. Their main characteristics are as follows:

Structural sectors—comprised of the five main urban linear growth "structures" in Curitiba. These accommodate the segregated lanes for the express buses, residential high density, commerce on the ground floors of new buildings, and services. They represent a linear extension of the central business district towards the north, south, east, west, and southeast (refer to Figure 3.1), following the trinary road system (see Figure 3–2).

Traditional center—where certain new commercial buildings are prohibited. Incentives are given to land use conversion for housing. New parking areas are not allowed. An inner ring road has been designated and a specific decree for creation of pedestrian areas was developed.

Priority areas for pedestrians—where motor vehicles have partial or no access at all. No supermarkets, parking, or access to car parks are allowed. Banking, insurance, or financial institutions cannot occupy the ground floor of buildings in these areas. No new buildings with more than five floors can be built with some exceptions for publicly desirable facilities.

Historic zone—all buildings in this area were classified under three categories: monuments (buildings), structures of general historical interest, and buildings without special historical value. Monuments cannot be altered outside or inside without permission from the public authorities. There are tax incentives for preservation of buildings with historical value and the facades of these structures cannot be changed without public permission. Units without special value can be demolished, if necessary, provided the plot is used for a new building with no more than three floors. Construction projects, advertising, and other displays on buildings in the historic zone need to be approved by IPPUC. Only the following uses are allowed: housing, cultural institutions, art galleries, restaurants, cinemas, theaters, small-scale commerce, and bars.

Connecting road zones—formed by the five axes that link a Structural Sector to the Curitiba Industrial City. These serve as small and medium-scale service axes with medium residential density in the vicinity of the Industrial City. New land development for this area must reserve 35 percent of public land for streets, public and community equipment, infrastructure, green space and protected streambeds (if applicable).

Collecting roads sectors—stretches of streets that "collect" and distribute the main traffic. They tend to be streets where the bus routes are located, offering more flexibility concerning commercial activities and mixed land use.

River basins—linear stretches following rivers and streams. The basic idea is to preserve these areas due to their particular importance for the hydraulic system of the region. Curitiba does not allow the building of roads, industries or warehouses in these areas. They are normally reserved for cycleways and inter connecting parks.

Santa Felicidade area—a traditionally Italian district of ethnic significance. The district also possesses substantial vegetation in the form of native woods. Legislation prohibits buildings of more than two floors and establishes compatible land uses.

Other special zones—the Curitiba Industrial City, military facilities, educational areas (universities), green areas/parks.

Because land use legislation has been crucial to altering the development of Curitiba, more detailed information on various aspects of the legislation is provided in Annex 1.

3.4 Enforcement: Innovations and Instruments

The basic philosophy for enforcement of innovations in the road system, public transportation, and land use is that any change should be enacted in a self-enforcing way. Curitiba has been in the forefront of integrative innovation: it was the first city in Brazil to implement not only pedestrian streets but also a whole pedestrian network; it was also first with segregated bus lanes and the trinary road system. A variety of innovative instruments have been used in order that Curitiba's urban structure could be shaped by integrating land use legislation and the public transportation network to direct urban growth.

Examples of Curitiba's different styles of enforcement include the following.

Regulatory and planning tools:

- the land use legislation requires that the Structural Sectors have a floor-to-area ratio of six, further enforcing urban growth and density alongside the axes;

- anyone wishing to obtain or renew a permit to engage in commercial activity must provide the Urbanism Department of City Hall with information used to project traffic generation figures, infrastructure needs, parking requirements, and other relevant impacts;

Economic Incentives:

- within the Curitiba Historic Area, owners · of historical buildings have the right to transfer the building potential of their plots to another area of the city. This means that, on the one hand, the law forbids owners of historical buildings to tear them down but, on the other hand, enforcement is achieved through a compensation mechanism;

- since 1990, through the Municipal Housing Fund Act building companies can "buy" up to two extra floors of built-up area beyond the legal limit in specific areas of the city. The payment for this extra built-up area is made to the Municipal Housing Agency (COHAB) with money or land to be used for low-income housing. The value of the payment is calculated at 75 percent of the market value of the extra area added to the building. The city only allows these additions in areas where the existing infrastructure can cope with the extra built-up area. This simple mechanism has been generating land and resources for low-income housing in Curitiba;

Physical Instruments:

- bicycle paths in Curitiba are physically segregated, as are bus lanes, because it would have been difficult to maintain separation otherwise; and

Informational Tools:

- city hall can deliver information to any citizen in five minutes about the building potential of any plot in the city. A transparent information system helps to avoid land speculation and has proven to be essential to the city budget, as property tax is the main source of revenue for the city.

3.5 Environmental Impact

The best way to appreciate the environmental impact of integrating the road network, public transportation, and land management is to see the city from above. From a plane or from the State Telephone Company Observation Tower, it is possible to visually determine the borders between different residential zones, distinguish commercial collecting roads from neighborhood ones, see the built-up line of "structural sectors" defining urban growth, and the protected green areas redirecting it. These have resulted in a more energy-efficient, greener city. One area where positive environmental changes are directly linked to urban management is in the transport sector.

Curitiba's public transportation system is used by more than 1.3 million passengers each day, or about 75 percent of all commuters, which is much higher than other Brazilian cities.[2] Twenty-eight percent of Direct route bus users previously traveled by car. This has helped secure savings of up to 25 percent of fuel consumption citywide, with related reductions in automotive emissions. Curitiba's public transportation system is directly responsible for the city having one of the lowest rates of ambient air pollution in Brazil. Another effect of Curitiba's transport policy is the budgetary savings for inhabitants in expenditure on transport; on average, residents spend only about 10 percent of their income on transport, which is a relatively low proportion for Brazil.

Due to a good working relationship with the private sector, Curitiba has one of the newest bus fleets in Brazil, with an average of three years of use. The average for other Brazilian cities is around eight years. The fact that the buses are newer and that the fare structure guarantees financial resources for proper maintenance of buses (see previous section on management and finance) help to reduce the amount of air pollution from circulating buses themselves.

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2. Comparable ridership rates for public transportation are 57 percent in Rio de Janeiro and 45 percent in São Paulo. Based on local data published in *The Economist.* April 17, 1993. p. 49.

Curitiba has created a positive feedback loop in its public transportation system where more people tend to use buses; increased ridership generates more resources that are then reinvested in the system, causing more people to use it. The high level of bus patronage is directly connected to the good quality of service. The International Institute for Energy Conservation (Washington D.C.) gave Curitiba its 1990 global energy efficiency award in recognition of the environmental benefits of this system.

4. OTHER INNOVATIONS FOR IMPROVING THE URBAN ENVIRONMENT

Over the past twenty years, Curitiba has undertaken a number of initiatives that have led to environmental improvements, as well as better management, poverty alleviation, economic productivity, and other objectives. The key areas where these innovations have been introduced are in municipal solid waste management, preservation of green space and cultural heritage, water and sanitation, industrial pollution control, and education/public information. The policies, projects and programs relevant to each of these areas are briefly described in this chapter.

4.1 Municipal Solid Waste Management

4.1.1 Background

Each inhabitant of Curitiba produces an average of 0.85 kg of garbage per day. The composition of this garbage is as follows; a) recyclables (metal, plastic, glass, paper)—35 percent; b) organic (food, agricultural by-products)—30 percent; c) vegetation/yard clippings (branches, leaves, grass)—12 percent; d) inert material (wood, cloth, rubble, rubber, leather)—21 percent; and e) hospital waste—2 percent. The Curitiba Metropolitan Area produces around 1,070 tons of municipal solid waste each day, of which three quarters are generated within the city with the remainder coming from the thirteen neighboring municipalities.

The Department of Street Cleaning operates within the Curitiba Environment Department and coordinates public and municipal waste collection. Public collection encompasses vegetation from municipal facilities and parks (branches and leaves), the Municipal Public Market, street markets, public buildings (City Hall, the State Assembly), the municipal zoo, hospitals, and other public facilities. Municipal collection has been contracted since 1984 through a public competition to a private company, LIPATER. This company has some 1,300 employees and is also responsible for street cleaning. City hall retains a staff of 150 for management and supervision of these services.

The city is divided into 98 waste collection sectors that have three pick-ups every week performed by 45 compacting lorries. Two special lorries collect 12 tons of waste daily from 180 hospitals and health centers. These lorries are staffed by specially protected teams and use tanks to collect contaminated liquids. A new project will allow the expansion of this service to 800 dentists, veterinarians, and medical clinics which produce some 4 to 5 daily tons of hospital waste.

In the central city, 28 km^2 are swept manually every day by 415 LIPATER employees. Sixty km^2 are swept at least once a week by six mechanical vans. Working in two shifts, three lorries with water tanks clean curbsides, sidewalks, the Municipal Public Market area, street markets areas, bus stops, and other locations.

The nonrecyclable garbage is taken to the Caximba landfill, a 46 hectare area that was inaugurated in 1989. It was originally predicted that this landfill would be used for 15 years but, with the implementation of the recycling programs (see below), the landfill will have a much longer life. Hospital waste is buried in controlled septic tanks located in high areas of the Curitiba Industrial City. The tanks are covered by lime stone powder and a one meter clay layer in sites that are far from any ground or surface water.

4.1.2 Innovative approaches

There are two innovative waste management programs in Curitiba that, in turn, are integrated with a series of social initiatives. The citywide "Garbage that is not Garbage" program consists of curbside collection and disposal of recyclable garbage previously sorted by households. The "Garbage Purchase" program, designed specifically for low-income areas normally located along riverine valleys, seeks to clean up areas that are difficult for the conventional waste management system to access by exchanging garbage bags collected by residents for bus tokens and parcels of surplus food.

Garbage that is not Garbage Program. This program began in October 1989 with an environmental education campaign in municipal

schools. A simple brochure with information about waste separation was distributed to children and households. Information about curbside collection for recyclables was also distributed to households. The main initial objectives were to increase public awareness about the waste problem by communicating it to children and to inform households about the days of the week for conventional waste collection and for separate recyclable collection. A television campaign was launched with actors dressed up as the Leaf Family; this was reinforced with school visits by the actors.

The recyclable garbage collection is performed by 20 special noncompacting green trucks which belong to the same private company that performs conventional garbage collection. These trucks have a small metal bell that makes neighborhoods aware of their arrival. The city was divided into 102 sectors for this type of waste collection.

The composition of recyclable garbage in Curitiba is as follows: loose paper—24.2 percent; glass—12.8 percent; objects—12.7 percent; rejects—12.4 percent; paper cartons—10.4 percent; metal—9.6 percent; soft plastics—9.5 percent; hard plastics—7.8 percent; and aluminum—0.3 percent. "Objects" include materials that the population thought might be recyclable and broken/second hand items delivered to the "Garbage that is not Garbage" vans. These include wood, cloth, used furniture, broken stoves, refrigerators, and other appliances. "Rejects" include materials that are potentially recyclable but without commercial recycling value at the moment. One example is styrofoam that is being shredded and used for filling in blankets distributed to day care centers and asylums.

The recyclables are taken to a public institution called FREI (Social Foundation for Education and Integration), a foundation linked to city hall that was founded in 1965. This foundation seeks to reintegrate ex-alcoholics and very low-income people into society by providing them with employment—in this case, waste separation. The separation is performed manually with the help of a conveyor belt; all infrastructure and machinery used were built from secondhand mechanical parts.

Paper and carton are pressed into bundles that are then sold to private companies. Glass is broken into smaller pieces and taken to another conveyor belt where it is washed and separated, normally by employees who have some form of physical disability. After separation the glass is kept in containers to be sold at a later date.

The FREI also stores second-hand items that are then sold at the municipal flea markets organized by the city. There is a special phone number in Curitiba for donations of broken or second-hand items that are picked up according to a specific collection schedule. The revenue of all these sales is re-directed to social programs.

The collection of recyclables, mainly paper, is not solely the domain of the "official" collection scheme. Some 1,000 informal collectors (*carrinheiros*) also collect recyclable waste with improvised trolleys and help the "Garbage that is not Garbage" program. In return, the city gives more dignity to their profession by recognizing their work as a useful contribution to an important task. Their work is also made easier because, instead of having to sort through mixed garbage, they can collect the recyclables along the streets that have been previously sorted by households.

Another aspect of the "Garbage that is not Garbage" program is the toy factory that was established by the city to recycle waste and provide employment. The idea began at a one-day workshop at the Curitiba Creativity Center when some 600 industrial design students developed various prototypes of toys. Prototypes were built after an actual recycling van delivered its contents for the students to work with. Those prototypes were taken to a toy factory that is located in the *Vila Pinto* favela, an upgraded slum area. It is housed in a circus-like tent where children make their own toys, inspired by the prototypes. Children are organized in groups of 30 in each class. There are classes daily from Mondays to Thursdays. Apart from making their own toys, children also make toys for day care centers and other municipal institutions.

Garbage Purchase Program. The second innovative waste management programme implemented in Curitiba is called "Garbage

Purchase." The genesis of the program is rooted in findings of the Municipal Health Centers. The Centers, located on the periphery of the city, had detected a constant increase in the number of diseases typically caused by rats and flies, i.e., by vectors that are spread by waste dumps. Whereas in other parts of Brazil the low-income population tends to settle on hilly terrain, in Curitiba they occupy river basins. Due to the specific topography of these areas, garbage accumulated as collection vehicles had no access to them.

The methodology adopted by the city to clean up those areas was simple but efficient. Instead of paying the private company to collect waste, the city began to pay local residents to gather waste in plastic bags. The payment was initially in bus tokens and later with bags of surplus food. The bags of food normally contain one or more of the following: rice, beans, potatoes, onions, oranges, garlic, eggs, bananas, carrots, and/or honey. Curitiba is located in an area surrounded by agricultural activities and these goods constitute surplus production that is sold to city hall below market prices. The plastic garbage bags are distributed to the population by neighborhood associations that receive an administrative fee from city hall that is equivalent to 10 percent of the value of transport tokens. The price per kilogram that the city is paying to have the garbage collected by the residents of these low-income areas is equivalent to that paid to the private company.

In addition to these two innovative waste management programs, Curitiba also implemented related projects. One of them is called the "Green Exchange," which is in fact similar to the garbage purchase program. The basic difference is that the Green Exchange accepts only recyclable garbage in exchange for bags of food. It is done in supermarkets, schools, factories, and through neighborhood associations. In a recent month, 21 tons of food were exchanged in schools, 61 tons by neighborhood associations and 10 tons in industries. Another innovative project related to waste management is called *Tudo Limpo* or "All Clean." Its main objective is to clean up specific areas of the city or empty plots where garbage has accumulated. Retired and unemployed people are temporarily paid by city hall to perform these services. In 1992, 2,500 people participated in the project, forming 120 teams that cleaned up 335

areas. 135 neighborhood associations are involved with the project, recruiting participants and supervising their work. This project generates employment and results in savings to City Hall, as it costs less than paying a private company for waste collection in these areas. Besides garbage collection, participants also perform other tasks like mowing lawns, planting flowers/trees, and mending fences.

4.1.3 Environmental impact

Over 70 percent of Curitiba's households participate in the recycling programs. An average of nearly 1,200 trees are "saved" every day[3] by the "Garbage that is not Garbage" program (based on paper collected by both the official and informal systems). In other terms, assuming that a small/medium sized woodland has some 200 trees, one could say that 5 to 6 woodlands are conserved each day. Between August 1991 and September 1992, the Curitiba Environment Department estimates that over 11,000 tons of paper have been recycled, equivalent to 221,000 trees. The Brazilian urban population is around 70 times bigger than the Curitiba population. If every Brazilian city implemented a similar program, Brazil would be "saving" some 84,000 trees or 350 to 420 woodlands every day, by paper recycling alone.

Sixty neighborhoods, containing about 31,000 families, have been involved in the garbage purchase program between its inception in January 1989 through to October 1992. Within this period, 1,803,000 bags of solid waste have been collected with an average weight of 8 to 10 kg. per bag. Public transport tokens (859,500) have been exchanged and 943,200 bags (1,200 tons) of surplus food were distributed. In addition, a new community spirit was created in these peripheral areas; vegetable gardens are now growing where before there was a waste dump. These areas are specially fertile due to the previous accumulation of organic material.

The results of the All Clean project are presented in Table 4–1.

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3. This is based on the assumption that one medium-sized tree is conserved for every 50 kg. of paper that is recycled.

Table 4–1. Results of the All Clean project

	1989–90	1991	1992	1989–92
Number of projects	31	64	118	213
Number of areas benefited	31	104	334	469
Number of teams	32	66	121	219
People employed	651	1,063	2,480	4,194
Grass mowed (m^2)	212,987	794,939	1,517,345	2,579,271
Are cleaned (m^2)	339,973	1,307,199	2,930,948	4,578,120
Pipe cleaned (linear m)	107,508	84,418	559,217	751,143
Waste collected (kg.)	351,140	2,121,750	4,345,182	6,818,072

Source: Curitiba Environment Secretariat, 1992.

4.2 Preserving Green Space and Cultural Heritage

4.2.1 Historical Development

In 1970, the city of Curitiba averaged only 0.5 m^2 of equipped green space per inhabitant. Despite rapid population growth, Curitiba has been able to expand green space one-hundredfold in twenty years and presently has around 50 m^2 per person. The manner by which this was accomplished is a lesson in environmental management—solving several problems with win-win solutions.

Flooding was one of the most serious problems that Curitiba faced. The city center used to have frequent floods; the damage they caused was magnified by the construction of dwellings and other structures along stream and river basins. In addition, during the 1950s and 1960s, most streams were covered and converted into artificial underground canals that made drainage more difficult. Necessary drainage works had to be dug underground at a very high cost. At the same time, new developments

on the periphery of the city were being constructed without proper attention to the drainage.

Beginning in 1966, some strips of land for drainage were created and certain low-lying areas were put off-limits for building purposes. In 1975, the remaining natural drainage system was protected by stringent legislation. River basins were classified as special areas demanding specific attention and protection. These preventive measures allowed the city to forego substantial new investments in flood control. As will be seen, they also protected open space that could later be turned into park land.

4.2.2 Forest and parks policy

Much of Curitiba's approach to developing and managing green space is linked to drainage and flood control. Stream protection strips were developed as linear parks and water bodies were protected by law with a comprehensive tree planting program. Other areas subject to flooding were also transformed into parks and made available to the population together with sports and leisure facilities. Some examples of these areas are:

- Iguazu Park and Curitiba Zoo (8,000,000 m^2);

- Barigui Park (1,500,000 m^2);

- John Paul II Linear Park—3 km long with an average width of 30 m., including native woods with an area of 300,000 m^2;

- the São Lourenco Park (150,000 m^2); and

- other linear parks were implemented alongside Barigui River, Padilhas Stream, Belem River, Pinheirinho River, Atuba River, Bacacheri River, and Juveve River, representing more than 200 km of linear park space with an average width of 50 meters, thus making over 10 million m^2 of leisure area available to people. This space was added to previously

existing parks such as Passeio Publico, Barreirinha, and Capao da Imbuia.

The parks are maintained by the *Guarda Verde* (Green Guards) who also provide environmental information to the public and are trained in first aid. In addition, there are community programs to encourage community care and maintenance of the parks. For example, the Association of Friends of the Park provides volunteers for a variety of tasks, the Boy Scout Bicycle Watch promotes and protects park property, and local schools use the parks to teach children about ecology.

The park system is well-integrated from a transportation perspective. Individual parks are increasingly interconnected through a network of bicycle paths. Park access is further enhanced via free green-colored public buses (PRO PARK line), modeled after trolley cars that are built from recycled city buses, that take people to and from the main parks on weekends.

The land use legislation also enforces a pro-green space policy with *the following measures:*

- all buildings in Curitiba outside the central area have to be set back five meters from the main street;

- only 50 percent of the area of residential plots can be built up and open space cannot be made impermeable so as to maintain the soils absorptive capacity and resit flooding;

- approximately 50 percent of the entire road network has been covered by tree planting programs with 200,000 trees planted along some 1,000 km of streets;

- existing woods in Curitiba are registered and specifically protected by land use legislation. Taxes are gradually reduced as an incentive for the preservation of these areas. The most recent survey listed 1,099 woods representing 4,000 hectares of green area, or approximately 40 million m^2; and

- one-third of the total area of the municipality is formed by low-density building zones, where vegetation is to be permanently preserved.

4.2.3 Historical and cultural preservation

Curitiba has a rich mix of ethnicities and this diversity is reflected in municipal policies and legislation. One example is the organization of the "Ethnic Gateways" at the entrance of some districts. The Italian and Polish gateways were built following architectural competitions. Japanese, Ukranian, and German gateways will be built in the near future, based on participation from these communities. Traditional houses of early immigrants are protected by the legislation and wooden houses of unique architectural features are listed as "Preservation Units."

Cultural preservation is also integrated with conventional park policies. For example, the John Paul II Linear Park was established with the involvement of the Polish community in Curitiba. People of Polish origin largely help with maintenance and organize celebrations and traditional dance festivals, thus giving more "character" to the park.

Historical buildings and sites are preserved both by zoning ordinances and incentives for rehabilitation and re-use. The result is that numerous urban facilities have been "recycled" for new purposes: an abandoned gunpowder depot was converted into the first theater outside the downtown area; the former army headquarters is now a cultural foundation; the old railway station has become the railway museum; a glue factory is being used as a creativity center; and a stone quarry has been transformed into an amphitheater that serves as the city's opera house.

4.3 Water and Sanitation

The water and sanitation system in Curitiba are managed by a state company called SANEPAR. The water system is considered satisfactory, reaching 92 percent of the population. Sewage remains one of the biggest problems, as only 50 percent of the population is connected to proper sewage systems.

The water service delivers some 11,936,500 m^3 of water per month, with 263,400 connections. Water consumption is measured in every building and some 373,700 units (households and others) are connected to the system. The length of the water network is 4,630,773 meters and it serves a total of 1,588,400 people, according to SANEPAR. The water collection and treatment system is conventional. There are three collection and treatment units: Taruma (Irai River) with a capacity of 1,000 l/second; Iguazu (Iguazu River) with 3,500 l/second; and Passauna (Passauna Lake) with 1,000 l/second. As another example of integrated policy (water and parks), one of the most recently created parks in Curitiba is the Passauna Park, situated around the 8 km^2 Passauna Lake, with an observation point and ecological interpretive walkways. The conventional water treatment system uses aluminum sulfates to fuse and sink impure particles that are then filtered out. Chlorine and fluoride are added after filtering.

The sewage system has 107,700 connections that reach about 195,900 units. The network consists of 1,779,337 meters of piping which reach 832,600 people, according to SANEPAR. The Belem conventional sewage treatment plant uses aerobic treatment with rotating carousel technology. The capacity of this plant is supplemented by the use of some 70 RALF (*Reator de Leito Fluidizado*) units, which are upflow anaerobic sludge blanket reactors. This is an anaerobic digestion technology that has been adapted for domestic sewage use throughout the peripheral areas of Curitiba, mainly near housing developments. At present, according to SANEPAR, some 70,000 housing units are being served by RALF units.

The water and sewage services in Curitiba are paid for by the consumers with differential rates for low-income consumers, households, and commercial/industrial users. Table 4–2 provides information on the current tariff structure.

Recently, Curitiba has investigated developing its own municipal sanitation company, possibly effective from 1993. The objective is to try to replace the concession for the service that was given to the state government (via SANEPAR) in the 1950s. If this occurs, Curitiba would be able to pursue several environmental objectives in its water and sanitation policy that are not currently being addressed by SANEPAR.

Table 4–2. Water and sewage tariff by consumer group

Consumer Group	Tariff (November 1992)	
Low Income	CR$	US$
Up to... 10 m^3	14,699	1.79
11m^3	17,059	2.08
12m^3	19,418	2.36
13m^3	21,777	2.65
14m^3	24,136	2.94
15m^3	26,495	3.23
Residential		
Up to 10m^3	34,145	4.16
11m^3 to 15 m^3	34,145 + 5,400 /m3	4.16 + 0.65 /m^3
16m^3 to 25 m^3	61,545 + 6,700 /m3	7.50 + 0.81 /m^3
26m^3 to 50m^3	128,545 +8,480 /m3	15.6 + 1.03 /m^3
beyond 50m^3	340,545 + 10,540 /m3	41.5 + 1.28 /m^3
Commercial/ Industrial		
Up to 10m^3	62,660	7.64
beyond 10m^3	62,660 + 6,700 /m3	7.64 + 0.81 /m3

Notes: Sewage Tariff = 80 percent water tariff
Social Water Tariff = 43 percent of normal tariff
Social Sewage Tariff = 50 percent of social water tariff
US$ at approx. CR$ 8,200 (late October 1992)
Source: SANEPAR

With relation to sewage, as there are no financial resources to solve the problem conventionally, an alternative decentralized policy for sewage treatment would be followed, rather than improving the conventional linear systems. The new approach would also be related to a comprehensive housing/transportation policy to reduce the tendency of illegal settlements alongside streams and water springs. With regard to water, one option is to separate its use in the household. For example, car washing and flushing toilets could be accomplished with less

expensive untreated water. An alternative source of supply would be rainwater that can easily be collected and stored for nonpotable uses in the household.

4.4 Industrial Pollution Control

The Curitiba Industrial City (CIC), which houses most of the city's industries, was originally designed to attract enterprises that have a limited environmental impact. The CIC is located at the average distance of 10 km from the center of Curitiba and houses 500 industries on 12.5 million m^2, 40 percent of which is green space. Currently, it directly and indirectly generates more than 200,000 jobs, or one-fifth of all available jobs in Curitiba without creating environmental problems. The selection of nonpolluting industries was done in a straightforward manner by marketing the site to other than heavy industries.

Up until 1988, the solid industrial wastes of the CIC were collected by a private company and discharged without proper care in various areas within the city and in neighboring municipalities. Industrial wastes are under the jurisdiction of the State Environmental Agency (SUREHMA). In 1988, SUREHMA issued a law making it compulsory for industries to dispose of their solid wastes on their own land. This solution has encouraged enterprises to reduce, re-use, and recycle wastes, to conserve and protect their own land resources.

A case-by-case study of all the 500 industries located in the CIC would be needed to accurately assess the environmental impact of this new disposal policy. IPPUC has recently commissioned such a study with the aim of developing a specific waste management plan for the CIC. A draft was completed in December 1992 and then presented to the industries within the CIC. These industries are presently considering the implementation of the recommendations contained in that study.

In addition to its innovativeness as a low-impact industrial park, the Curitiba Industrial City has generated some of its own novel environmental activities such as:

Da Pedal—a program that enables the employees of the various industries to buy bicycles by using their monthly transport vouchers;

Software Park—one of the first areas in Brazil specially designated for computer-related industries and software development, with all necessary infrastructure;

Training—the CIC offers technical training courses, like the "Course on Solid Industrial Waste" in coordination with universities and with the Association of Industries of Curitiba; and

Recycling—the CIC is also beginning to participate in the "Garbage that is not Garbage" program, with specific collections for industries that produce recyclable industrial waste. This program collects primarily paper and metal.

4.5 Environmental Education

At present, the official policies of the city of Curitiba identify children's welfare and environmental management as top priorities. The action plan for children focuses on urban poverty so the environment is seen not only as green areas but also as the social and educational milieu in which the citizens of tomorrow grow up.

Ignorance is a key cause of environmental degradation. By providing environmental education, the city hopes to improve the quality of life of low-income households, especially the children, and teach them to be responsible for their actions. Environmental education is not taught as an isolated discipline in municipal schools; instead, it is inserted in the curriculum of other subjects like mathematics, geography, history, and Portuguese.

In order to complement and improve the level of formal education given to children, Curitiba has Centers for Integrated Education near conventional municipal schools. These are pre-fabricated units with open floor plans, i.e., without conventional classrooms. The furniture is composed of simple modules in the form of cubes, without chairs and

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Box 4–1. Integrating Environmental Education and Social Services—The Infant and Adolescent Environmental Education Programme (PIA)

This program was created to educate children from the favelas and other low-income areas. PIA units are generally a simple room with a wood-burning stove for cooking and heating. These units offer a place for children to go to during the day. They are given a meal with the food usually prepared by volunteer mothers.

There are 22 operating PIA units and a total of 28 were expected to be operating by the end of 1992. Each unit looks after an average of 250 children. For every 300 children there are only two official employees and volunteers, making this program very inexpensive to run. Prior to PIA, no infrastructure existed to support any kind of day care. Most children wandered around their neighborhoods unsupervised while their parents were at work.

With the implementation of PIA, the children have a place that provides them with meals and practical education. Initially, there was some vandalism from local gangs, but with patience from staff and educators, and without police intervention, the gangs began to become involved in the Program. Among other things, PIA youngsters are taught how to take care of younger children, how to clean and grow vegetables, and other skills that they can use for daily life. For example, many teenagers are learning gardening skills and money earned as gardeners is passed on to their favela neighborhood association.

Before PIA, favela children were often socially isolated. Now they feel more part of a community and participate in cleaning, washing-up, and cooking. Communities, in turn, are satisfied with the results of the Program and support its activities. Family life has improved and the surrounding environment is being protected and improved instead of being destroyed. This program was given a United Nations Local Government Honors Program Award from the International Council for Local Environmental Initiatives for "environmental regeneration of low-income communities."

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tables. These centers employ specially trained teachers, normally better prepared than those in municipal schools. Children attend the conventional school for half of the day, and a Center for Integrated Education during the remainder of the school day. Currently, there are 31 centers in operation.

For favela communities, a policy of "self-reliant" education is pursued that will teach the inhabitants to respect and care for the environment where they live and from which they may benefit. One of the programs to address this need is the Infant and Adolescent Environmental Education Program (PIA) that is highlighted in Box 4–1.

There are also other programs undertaken by the Children's Department of City Hall:

Casas de Apoio (support houses)—City Hall pays the rent for 12 houses that are staffed through agreements with nongovernmental social assistance institutions. This program is addressed to children who do not have a family, supporting girls from age 7 to 17 and boys from age 14 to 17. At present, 70 children are being looked after and receiving technical training.

Agreements with Community Associations—1,188 children and adolescents are looked after through 26 agreements signed in 1992 with community associations. City Hall provides financial and technical support for clothing, food, and social assistance.

Paperboy Program—this provides training, work, and social assistance for boys between 11 and 14 years of age to prevent early marginalization. A compulsory condition for their participation is to attend classes at the program's school.

SOS Children—this is a telephone service with a 24-hour number to register complaints/questions about mistreatment or negligence towards children. The rotating permanent team receiving calls is also instructed on how to take action or how to get judicial support, if necessary.

Street Market Children—this project consists of organizing boys and girls working in street markets (mostly delivering parcels and helping people by carrying their shopping). City Hall gives them a uniform and provides training. Apart from feeling useful and integrated, they also receive a nominal payment for their work.

For pre-schoolers up to the age of six, Curitiba has a network of 113 day care centers. Seven of these are maintained by private initiatives in partnership with the city. Four meals a day are served in each center which, in total, cater to about 12,600 children. There is also a program of "substitute mothers" who look after the children in their neighborhoods while their mothers are at work.

For adults, there is a practical education program called *Linha do Oficio* (the Job Route), which is operated in a series of recycled buses working as mobile teaching offices. At present, 26 different courses are being offered such as carpentry, handicrafts, electrical engineering, hairdressing, painting, printing, word processing, and basic accounting. The buses move from one low-income neighborhood to another on different days of the week. The teachers are recruited mostly within the same neighborhoods where courses are offered. The courses vary from 30 to 170 hours in duration with an average of 20 students per course. This program employs around 350 people for its operation and has allowed hundreds of graduates to find jobs.

Another important educational tool for adults was recently launched—the Free Open University for the Environment. This institution provides courses for people from all backgrounds (for example, taxi drivers, journalists, and teachers) to encourage awareness of the environment and the importance of its preservation. It is also involved in research and in development of local environmental projects, and is creating a library.

5. CONCLUSIONS

Curitiba's experiences with innovation in environmental management demonstrate some principles that may be applicable elsewhere.

- An urban growth pattern should be established in conjunction with a conscious decision to promote an integration of different elements of urban development. A city must know where it is growing, how, and why. Conscious technical, political, and economic decisions should be made in response to existing trends. Many urban related problems linked to the uncontrolled physical expansion of cities (for instance, increasing infrastructure and service costs, loss of agricultural land, or inadequate open space) can be avoided if correct decisions are made at the right time.

- It is important to establish a close relationship between the public transportation system, land use legislation, and the urban road network. This can provide an integrated framework to guide development.

- Successful decisions are also related to conscious technological choices and, in many instances, the most appropriate choice may represent a challenge to certain technological dogmas. Curitiba has showed that a city with more than one million inhabitants does not necessarily need an underground transport system or a light rail system, and that surface solutions based on buses can be developed incrementally at a much lower cost. The city's solid waste program has also shown that the recovery of recyclables from household wastes does not need an expensive mechanical separation plant if a city transforms every household into a pre-separation plant with curbside collection schemes.

- Cities should pay attention to their invisible as well as visible structure (transport, housing, land use, etc.). The network of formal and informal economic relations should be supported and not hindered by urban planning actions.

- The existence of an institution with technical staff who serve but transcend mayoral administrations can provide expertise and channels of communication between actors, and contribute to the stable implementation of programs and policies over time.

- Top priority should be given to public transport rather than to private cars, and to pedestrians rather than to motorized vehicles. In Curitiba, less attention to meeting the needs of private motorized traffic has generated less use of cars. Bicycle paths and pedestrian areas should be an integrated part of the road network and public transport system.

- A sustainable city is one that uses the minimum and conserves the maximum. This is a pragmatic application of the principles of recycling. In Curitiba, this is exemplified by solid waste recovery, re-use of old buses as mobile schools, preservation and use of historic dwellings, and employment policies (low-income people being employed in the garbage separation plant and as teachers of environmental education courses).

- The example of Curitiba demonstrates that there is can be an integrated and environmentally-sensitive action plan for each set of problems. Solutions within any city are not specific and isolated but interconnected. The action plan should involve partnerships between responsible actors such as private sector entrepreneurs, nongovernmental organizations, municipal agencies, utilities, neighborhood associations, community groups, and individuals. This approach implies that the whole debate in favor of or against privatization loses its importance when there is a role for each actor within a given community and city and that these roles can be complementary.

- The role of every actor is a function of scale, means, and knowledge. For instance, the city administration should be in a position to determine structural guidelines for the city and its wider region, whereas citizens can better determine what

is best for their own street or neighborhood. Balance between representation and participation is essential.

- Creativity can substitute for financial resources. Ideally, cities should turn what are traditional sources of problems into resources. For example, public transport, urban solid waste and unemployment are traditionally listed as problems but they have the potential to become generators of new resources and employment. Creative and labor-intensive ideas can, to some extent, be substitutes for capital- intensive technologies.

- A good information system is essential. The better the inhabitants know their city, the better they treat it. A team of officials should be developed locally who know the city well and who are committed to developing it.

Another lesson is one of cost. Curitiba is no richer or poorer than other southern Brazilian cities. Its innovations have been financed mostly from the annual budget that currently stands at US$250 million, much of which is raised from property taxes. Curitiba spends $156 per capita to deliver all its services.[4] The Curitiba difference is that these funds are spent on integrated, common-sense programs and projects that are environmentally sensitive.

One feature that may not be transferable is the political commitment, leadership, and continuity that Curitiba has enjoyed over the last twenty years. Much of this is attributable to one person—Mayor Lerner—who initiated and implemented many of these innovations during his three terms in office (1971–75, 1979–83, 1989–92). Trained as an architect and planner, Mayor Lerner combined the skills of a professional with those of a charismatic politician to promote the environmental reforms and initiatives that are referred to in this report. This advocacy paid off: according to public opinion surveys, 99 percent of Curitiba's citizens

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4. Kris Herbst, 1992. "Brazil's Modern City," *Planning*. p. 27. (September).

would not want to live anywhere else[5] and Mayor Lerner maintained a 70 percent approval rating during most of his time in office.[6]

Finally, Curitiba is not without its unsolved problems. Only 55 percent of the population is connected to the sewage system, and much of the sewage is not treated prior to final disposal. At the present this is the fault of the state government which is responsible for urban sanitation through Parana. Within the city's domain, about half of the city's school children do not complete grade school and around eight percent of its citizens live in slums. Theses figures are similar or higher in other Brazillian cities. Thus, there are still important problems awaiting innovative solutions.

Many of the ongoing problems stem from the fact that the cities cannot be managed in isolation from state and national governments. Curitiba is not an island within Brazil and presents structural characteristics that reflect a broader social and economic context.

The innovations and accomplishments in Curitiba offer two global lessons:

- it has proved that city administrations do not need to wait for broader structural designs to begin working on some of their problems;

- it is important that state and national governments, as well as the international community, should acknowledge the strategic importance of cities as potential instruments for positive development and change.

5. Christina Lamb, 1991. "Brazil City In Vanguard Of Fight Against Pollution." *Financial Times.* (August).
6. John Maier, Jr. 1991. "From Brazil, the Cidade that Can." *Time.* (October).

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ANNEX 1: LAND USE LEGISLATION

A1.1 Historical Development

The hierarchy and function of different roads in Curitiba is determined by land use legislation. At the same time, the limits between two different zones in Curitiba is deliberately determined by a specific road or street. Given the operational proximity between land use and the road system, these two aspects will be described together.

The Brazilian civil framework is basically comprised of three branches of government: Executive, Legislative and Judicial, at the national, state and city levels. At the city level, the executive power is represented by the Mayor and City Hall; the legislative power by the Municipal Council; there are no judges/courts of justice at the municipal level.

New laws are proposed by the Mayor or any member of the city council and require a simple majority of Council members to be approved. Decrees are used by the Mayor as regulatory and/or operational documents to detail the concepts and policies stated in laws. Sometimes the law delegates to the Mayor the power to define or decide on some matters; this is the case with the Land Use Law (this kind of delegation of power is relatively unusual). In Curitiba, laws referring to new expenditures or land use regulations cannot originate from a Council initiative and must be proposed to the Council through the Mayor's office by the proper technical agency of the Municipality.

The *Legislacao do Uso do Solo* (Land Use Legislation, IPPUC, 1992) lists the texts of 66 laws and decrees issued from 1969 to 1992. These texts (14 Laws and 52 Decrees) regulate what this paper calls "Curitiba Land Use Legislation." The texts do not regulate all land use aspects but constitute the fundamental base for action.

Curitiba Land Use Legislation throughout time shows a very strong but flexible concern with the relationship between land regulation and urban growth. The legislation therefore reaches not only a static physical

Table A1–1. Law 5234/75—land uses in Curitiba

Zone	Allowed uses	Tolerated uses	Allowed on request	Prohibited	Comments
ZR1 Residential only	One family (o.f.h.)			All other uses	
ZR2 Low density	o.f.h. Neighborhood Commerce and Services			All other uses	
ZR3 Medium density	o.f.h. Collective housing neighborhood commerce and services			All other uses	
ZR4 Mixed	Collective housing commerce and services Group A	o.f.h.	Commerce services Group A	All other uses	Specific decree for parking lots
ZR5 Inside Industrial City	o.f.h. and collective housing neighborhood commerce/ services			All other uses	
ZR-Rec (Recuperation)	As in ZR4 services Group A			All other uses	
Central	Collective housing neighborhood and district commerce/ services	o.f.h.	Group A outside inner ring road	Parking lots inner ring road	No parking lots in pedestrian areas, no supermarkets
Services	Collective housing neighborhood and district commerce/ services	o.f.h.	Group A outside Inner Ring Road	Parking lots– Inner Ring Road	No parking lots in pedestrian areas, no supermarkets
Industrial outside CIC	Wood industries	o.f.h.	Nonhazardous small scale industries	All other uses	No traffic generation activities in Floriano Peixoto Ave.
Inside CIC	To be defined by URBS			All other uses	

dimension but also a dynamic one throughout time. On the one hand, the legislation has had a fundamental role in providing regulatory guidance for the urban growth pattern designed for Curitiba. On the other hand, it

Table A1–2. Building regulations in Curitiba

Zone	Maximum height	Minimum lot/ front lot ratio	Footprint/ lot ratio	Minimum frontage	Comments
R 1	2 pavements	15/6,000	1/2	5m	
ZR2 Residen- tial only	2 pavements	12/360	1/2	5m	
ZR3 Medium density	2 pavements	12/360	2/3	5m	
ZR4 Mixed	6 pavements	15/450	1/2	5m	
ZR5 Inside Industrial City	6 pavements	To be determined by URBS			
ZR-Rec (Recuperation)	4 pavements	12/360	1/2		
Services		12/360	1/2	5m	Traffic generation activities frontage 10m
Industrial outside CIC		20/360		10m	
Inside CIC		To be determined by URBS			
Agriculture zone		5,000 m	1/5	15m	

evolved, being changed or becoming more detailed as the city grew, without losing the basic principles of the Curitiba Plan.

A1.2 Structure

The fundamental structure of the Curitiba Land Use legislation is defined by law 5234 from 1975 which amended law 4199 of 1972. This law defines six basic zones: Central, Residential, Industrial, Service, Agriculture, and Special. This last category will be presented in more detail below.

For each one of these zones, the law defines uses that are allowed, tolerated, tolerated upon request, and forbidden. The requests and special cases are analyzed by the Zoning Council formed by members of City Hall and the Planning Institute.

Law 5234 also defines the densities in these zones by defining building parameters. Uses and densities throughout the different zones are specified in Tables A1–1 and A1–2 which are part of this Law. Decree 880

from 1975 establishes definitions and dimensions for the uses described in the Land Use Tables with relation to activities, nature and scale.

With Relation to Activities:

- Housing

  - One family housing—single family
  - Collective housing—sheltering more than one family

- Commerce and Services (divided into 5 groups)

  - Neighborhood—small scale activities, within residential zones, with nonhazardous uses, such as: bakeries, butcher shops, pharmacies, newsstands, etc.

  - District—Medium Scale Activities, divided in there groups.

    - Group A—Key maker, Shoe Shops, Barber shops, Saunas, Beauty parlor.
      - Tobacco shops, Candy shops, Book Stores, Stationery Shops, Antique shops, Art shops.
      - Professional services offices.

    - Group B—Medical clinics, Dentists, Veterinarians
      - Travel agencies, Post office, Banking agencies
      - Hardware shops, Shoes and clothing stores, Restaurants/Cafes.

    - Group C—Day Care Centers, Religious Institutions, Domestic Appliances stores, Repair Shops, Markets, Night Clubs

  - Sectoral—Large scale activities that affect the population in general.
    - Hotels
    - Department stores
    - Supermarkets

- Cinemas, Theaters, Clubs
- Financial Institutions

- General—Activities that affect the whole population which, due to their nature, require physical limitations.
  - Large scale repair shops
  - Warehouses
  - Cooperatives, Grains storage
  - Car repair shops
  - Printing offices

- Specific—Special cases to be analyzed by the Zoning Council, divided in two groups.

  - Group A— Public Access Structures
    - Schools and Entertainment establishments
    - Places for religious festivities and ceremonies
    - Hospitals
    - Car parks (including multi-story ones)
    - Petrol stations
    - Federal, state and municipal buildings

  - Group B—Circus, Amusement parks
    - Camping sites
    - Stone Quarries, Sand Extraction
    - Motels
    - Sport Activities

- Industry—"activity which results in the production of goods through the transformation of basic materials"

  - Mineral and nonmetallic products industries
  - Metal industries
  - Mechanical industries
  - Electronics and Telecommunications industries
  - Transportation Materials industries
  - Wood industries
  - Furniture industries
  - Paper, Carton, Cellulose industries

- Plastics and Rubber industries
- Textile industries
- Food Processing industries
- Drinks industries
- Tobacco industries
- Building industries
- Public utilities industries
- Chemical, Pharmacy and Cosmetics industries

Zoning for the Curitiba Industrial City was created by Law 4773 of 1979 and then modified by Law 6204 of 1981. The latter attempts to give the Industrial City a more mixed character, providing the following sub-zones within the Industrial City:

Industrial	Nonpollutant and nondangerous uses allowed depending on approval from the Zoning Council and the State Environmental Agency (SUREHMA).
Support Services	Services to Industry and Housing.
Cargo Terminal	Specific area and implementation plan approval by City Hall.
Special Services	General services; Small scale commercial activities; small scale nonpolluting industries.
Mixed Uses	Commerce and services; single family housing and collective housing; small scale nonpolluting industries.
Housing	Single family housing and collective housing; small-scale commercial and service activities.
New Curitiba	Single family and collective housing; commercial and service activities; New Curitiba is located alongside the main axis going towards the Industrial City.

This legislation gave the Industrial City a "district" and a "neighborhood" feeling, thus limiting the space for industries and creating new residential, commercial and service areas within the industrial zone itself. A new bus terminal and bus routes crossing the Industrial City contributed to make it one of the newest, and actually the biggest, district in Curitiba.

- IV. Agriculture—"Activity in which the fertility of the soil is used for the production of plants and breeding animals - for the needs of the producer or the market." Curitiba is mostly an urban municipality; the protected Agriculture Zone within the city is comprised of 23 percent of the area of the city.

With Relation to the Nature of Activities:

- Dangerous—"Those (products, activities) which may produce explosions, fires, emission of hazardous gases, dust or any other harmful sub-product that can cause danger to people or property."

- Disturbing—"Those which can produce noise, dust, emissions or any other disturbances to the neighborhood."

- Pollutant—"Those which present health risk or any form of pollution risk due to their manipulation of ingredients or production process."

With Relation to the Scale of Activities:

- For commerce and services:

  - Small scale: up to 60 m^2 of built-up area and maximum floor height of 3m.

  - Medium scale: up to 200 m^2 of built-up area.
  - Large scale: over 200 m^2 of built-up area.

- For industries:

  - Small scale: Buildings on sites of up to 4000 m^2.

  - Medium scale: Buildings on sites of up to 20,000 m^2.

  - Large scale: Buildings on sites over 20,000 m^2.

- Special Zones:

  - Apart from the conventional zones previously presented, Curitiba also has a series of Special Zones which were initially created by Law 5234 of 1975 and later detailed in specific decrees.

A great challenge for the development of any Land Use Legislation is the definition of flexible and workable limits between the rules and the exceptions. No land use legislation can refer to all possible situations that could happen in a city; any attempt to develop an excessively comprehensive legislation could result in a cumbersome, bulky and not very useful document. On the other hand, an excessively general and loose legislation may leave many loopholes that may fail to control urban land development.

About the Authors

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