ROUEN, FRANCE

BRIEF: TEAR OPTICALLY GUIDED BUS

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CITY CONTEXT

The urban agglomération of Rouen is located about 250 kilometers [155 miles] from Paris, London, and Brussels. Its 33 communities contain about 390,000 residents in an area of 292 square kilometers [about 112 square miles]. The population density is about 1,335 persons per square kilometer [3,500 per square mile]. Slightly more than 100,000 people live within the downtown area.

Public transport is provided by Transports en Common de L'Agglomération Rouennasse (TEAR) over the entire urban agglomération. TEAR operates 143 standard buses, 53 articulated buses, 28 light rail vehicles and 8 minibuses. There were about 14 million bus passenger boardings and 15 million light rail transit (LRT) boardings in 1999. Some 5.2 kilometers [3.2 miles] of 481 kilometers [298 miles] of bus routes are on priority rights-of-way. The bus system carries 90,000 riders, and the LRT system carries 60,000 each day.

PLANNING AND IMPLEMENTATION BACKGROUND

In 1977, TEAR was pursuing construction of a second light rail line and issued a turnkey request for proposals. Proposals received resulted in costs of about $25 million per mile. Because these costs exceeded TEAR's budget, LRT was dropped in 1998 in favor of a bus-based system.

The decision to develop an optically guided bus system was made in July 1999. The cited reason for using articulated "rail-like" vehicles was that the capacity of 1,500 people per hour per direction with regular buses was believed insufficient, while the 8,000 figure for trams was believed excessive. The Civis buses with optical scanning capabilities could carry 3,000 to 4,000 people, and because they do not require digging up roads, they would be much cheaper than building a tram system.

The optical guidance system was selected over a system using embedded tracks, because the vehicle track (path) may be modified, which reduces roadway wear.

PROJECT DESCRIPTION

A three-route bus rapid transit (BRT) system was placed in service in 2001. Civis guided buses use optically guided scanners in curb or median lanes to assure proper positioning at the station. The three-line system essentially uses rubber-tired trams. Neighborhood revitalization and urban design features were integrated with system development.

The initial bus fleet included 38 "Agora" guided articulated vehicles (essentially guided conventional buses) and one Irisbus Civis diesel electric articulated vehicle. The Agoras will be replaced by 56 additional diesel electric Irisbus Civis guided articulated buses. Total costs, including 57 Irisbus-Civis vehicles, were $165 million in U.S. dollars (about $10 million per route mile).

SERVICE PATTERN

The three-route "TEAR" guided bus system is shown in Figures 1a, 1b, and 1c. There are three overlapping lines. Line TI connects Mount-Saint-Aignan with les Hauts de Rouen; the 14.1-kilometer [8.7-mile] line has 31 stations. Line T2 connects the Vallee de Cailly with Darnetal; the 12.2-kilometer [7.6-mile] line has 30 stations. Line T3 connects Canteleu with Plateaux Est; the 19.8-kilometer [12.3-mile] line largely operates in mixed traffic. In the central area, the three lines follow a common alignment. Buses operate along curbs in mixed traffic and along single curb lanes each way, as well as along single or double median bus lanes (See Figures 2, 3, 4).

VEHICLES

The single-articulated Agora bus is 17.8 meters [58 feet] long and has 40 seats and a total of 110 places. The single articulated Irisbus Civis, 59 vehicles of which will be available by 2006, is 18.6 meters [about 61 feet] long, has 41 seats, and 120 places. (See Figure 5.) As shown in Figure 6, it has a train-like interior appearance.

The Irisbus Civis is a joint venture of Renault and Fiat's industrial vehicle company, Iveco.[1] The Civis buses are propelled by electric motors mounted on the wheels. A diesel engine runs an alternator that produces the needed electricity. Because there is no drive shaft or transmission, the cabin floors are flat from the front door to the back window, with no steps that passengers need to negotiate. Instead, the doors open at the level of the curb so that people can enter or exit in groups, as they would on a subway car (Figure 7). Those in wheelchairs can roll onto the bus.

The image processing software linked to the dashboard camera continuously compares the bus's trajectory with the stripes painted on the roadway, looking about 100 feet ahead. The optical scanning system works even if only one-third of the stripes are visible. Before the motor on the steering column makes each adjustment to keep the bus on course, the software checks with sensors on the steering column and on the front axle that measure the angle of the bus's wheels to make sure that the adjustment will work as intended. For emergencies, there are both visual and audible alarms to warn of malfunctions. If the driver does take over, the optical system is automatically overridden. Optical scanning is done by double white lines painted on the street.

The great advantage of this optically guided bus is its precision. Buses can dock within 2 inches of the curb so that all the doors line up with the platform. This precision eliminates the need for wheelchair ramps, a major time delay. The other advantage of optically guided steering is that buses with the technology require a narrower roadway—typically 5 feet narrower—than buses that rely on humans to guide them. The smaller paths the buses use make them particularly suited to tight spots like median strips, road shoulders, and tunnels.

Civis buses have global positioning satellite (GPS) equipment that tracks their location. This information is transmitted to displays at the stops so that riders will know when the next bus is coming. The French vehicles also have controls that let the drivers change traffic lights ahead to avoid slowing down.

STATIONS

Stations are equipped with maps, shelters, and fare collection facilities. There are 1000 free parking places for bus users at the Pôle D'Échanges where three bus routes converge. Figure 8 shows the arrangement of the central station.

FARE COLLECTION

Fare collection is at stations or on board vehicles. Users must validate tickets, which are good for 1 hour of service on any mode. Tickets are available in a per-trip 7-day package or 1-year package. Fares are reduced for the elderly and children. A magnetic card reader is available at the entrance of each bus.

TRANSIT CONTROLS

The "Transportation East-West Rouen" (TEAR) buses have priority at all but the three intersections where buses merge or diverge. The buses have a signal priority via radio signal from the vehicle to the traffic light. If this communication fails, traffic signals can be changed manually by means of a remote control unit in the vehicles.

Traffic signal displays have an additional light that is illuminated upon confirmation of the signal from buses. If this light does not illuminate, the bus driver has 7 seconds to respond with manual override.

Twenty intersections require opposing TEAR vehicles to pass each other on a single dedicated lane. During these passes, motor vehicle traffic is stopped to enable buses to utilize the general purpose lanes.[2]

COST COMPARISONS

Costs, as estimated by Civis, for a 15-vehicle, 10-mile, 20-station system are shown in Table 1. Costs total $38 million for vehicles and system implementation, $59 million for construction, and $25 million for "soft costs," for a total of $122 million, or approximately $12 million per mile. Corresponding costs for an LRT line would be $495 million, or almost $50 million per mile.

APPLICATION IN THE UNITED STATES

The optical scanning system has potential applicability in the United States in select operating environments where space is at a premium and where precise positioning of buses is essential. Examples include the existing bus tunnel in Seattle and the proposed Silver Line Tunnel in Boston. It is reported that Las Vegas is considering this system for its planned BRT line. The major constraints of snow and ice preclude application in northern parts of the United States and all of Canada. Further testing of the system is desirable before any large-scale application.

REFERENCES

1. Eisenburg, A., New York Times. July 20, 2001.
2. "Rouen's Civis Revealed," Urban Transport International, No. 33, January-February 2001. FTA BRT "Vehicle Scanning Tour", November 9-17, 2000.

Table 1: Comparative At-Grade LRT vs. Civis Transit

(10 MILE, 20 STATION, 15 VEHICLE SYSTEM)

		$ MILLIONS PER MILE OR PER UNIT			
		LRT		CIVIS	
SYSTEM					
Vehicle	Per unit	3	45	1.1	16
Guidance	Per unit	-	0	0.1	2
Signaling and Controls	Per mile	5	50	1	10
Communications and Signaling	Per mile	0.7	7	0.3	3
Power Supply & Distribution	Per mile	6	60	-	0
Pre-Revenue Testing	One project	3	3	2	2
Fare Collection	Per station	0.25	5	0.25	5
SUBTOTAL		***170***		***38***	
CIVIL WORKS					
Guideway/Track Bed or Roadwork	Per mile	10	100	3	30
Stations	Per unit	1.5	30	0.2	4
Maintenance Facility & Tracks	One unit	10	10	2	2
Infrastructure (3 rail and PDS)	Per mile	4	40	-	0
Utilities Relocation	Per mile	1	10	0.3	3
Traffic Maintenance	Per mile	2	20	0.5	5
Land Acquisition and Landscaping	Per mile	1.5	15	1.5	15
SUBTOTAL		***225***		***59***	
SOFT COST (25% OF SYSTEM/CIVIL)					
Project Management	10%	40		10	
Construction Management	5%	20		5	
Design	5%	20		5	
Planning & Prelim Engineering	5%	20		5	
SUBTOTAL		***100***		***25***	
TOTAL (10 MILE, 20 STATION, 15 VEHICLE SYSTEM)		***$495 Million***		***$122 Million***	

Note: Many factors can effect per mile calculations; certainly longer length and larger fleet size systems cost less per mile than smaller ones.

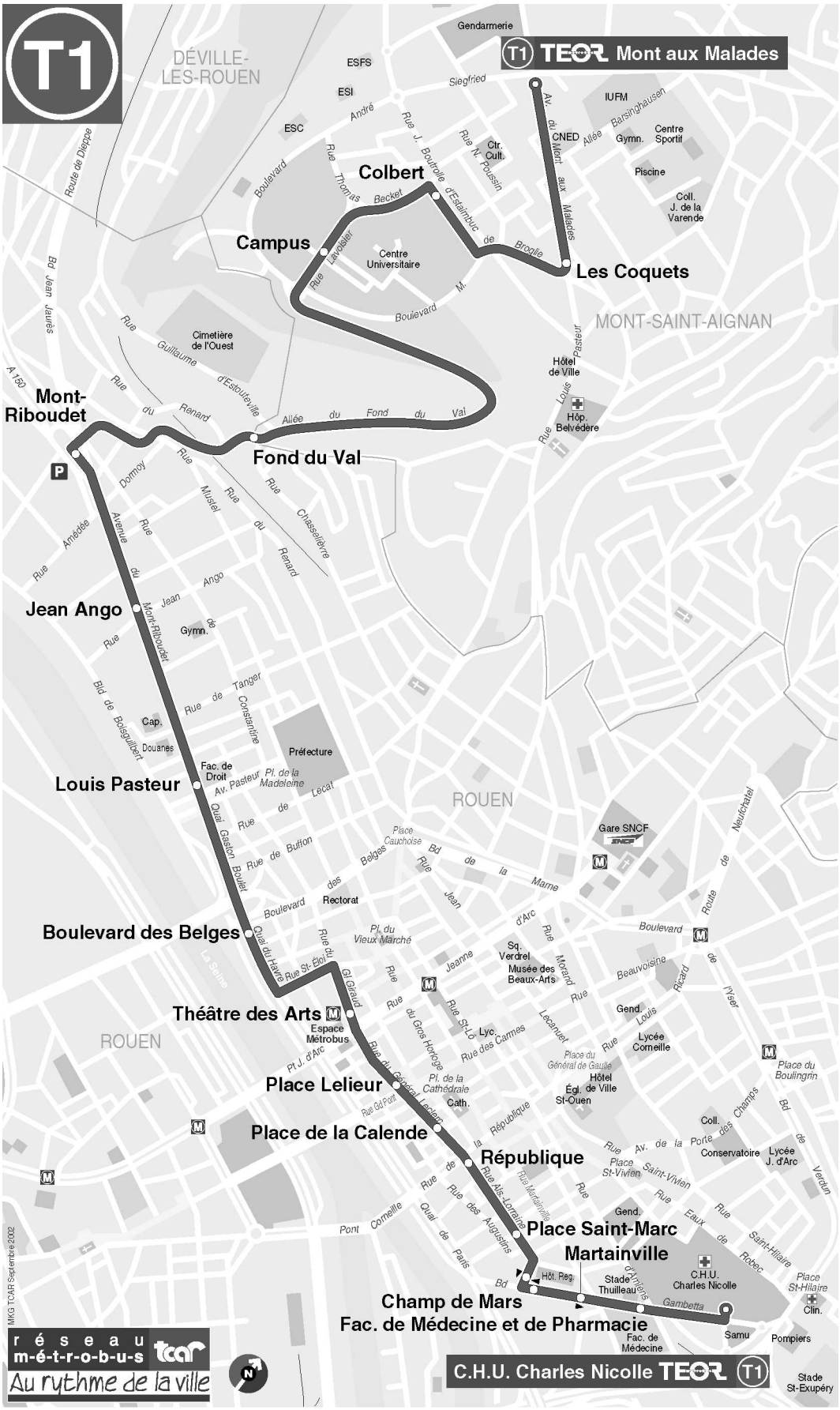

Figure 1a: T1 Mont Saint Aignan Route (14.1km, 31 Stations)

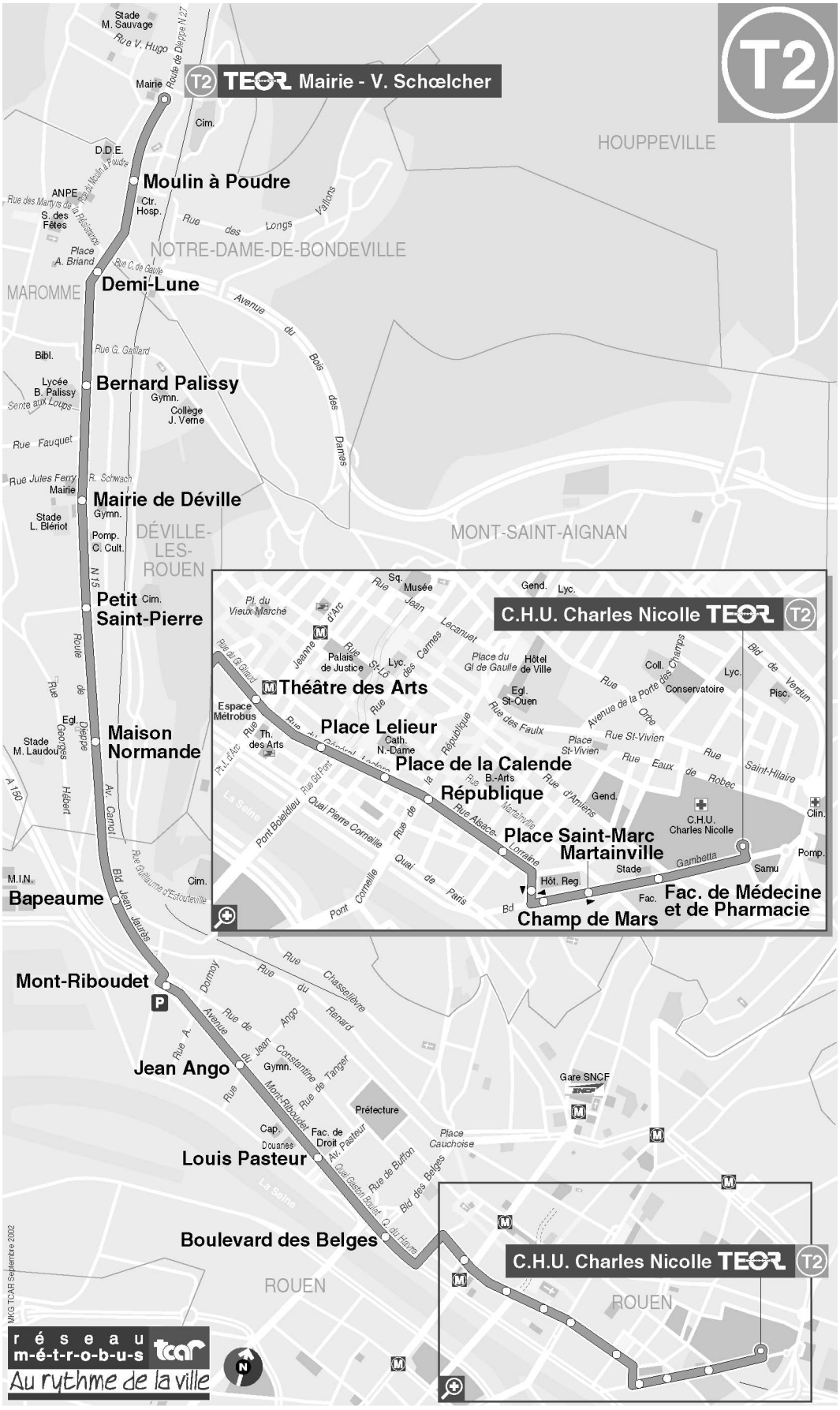

Figure 1b: T2 Vallée du Cailly – Darnetal (12.2 km, 30 Stations)

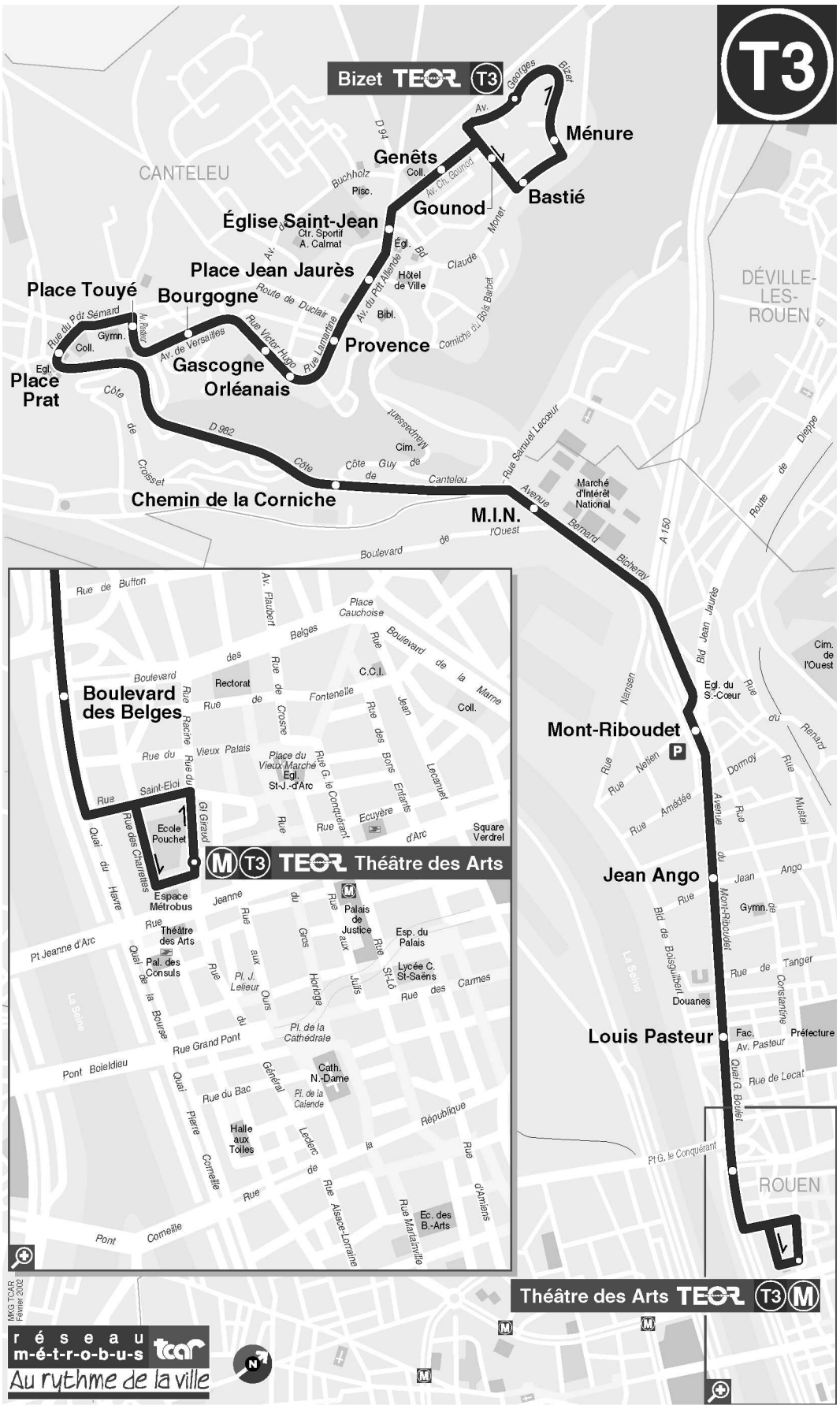

Figure 1c: Canteleu – Plateaux Est (19.8 km)

Figure 2: Two-lane Operation

Figure 3: Single-lane Operation (on a Narrow Street)

Figure 4: Two-lane Operation at Station

Figure 5: Irisbus Civis

Figure 6: Irisbus Civis Interior

Figure 7: Irisbus Civis Loading at Station

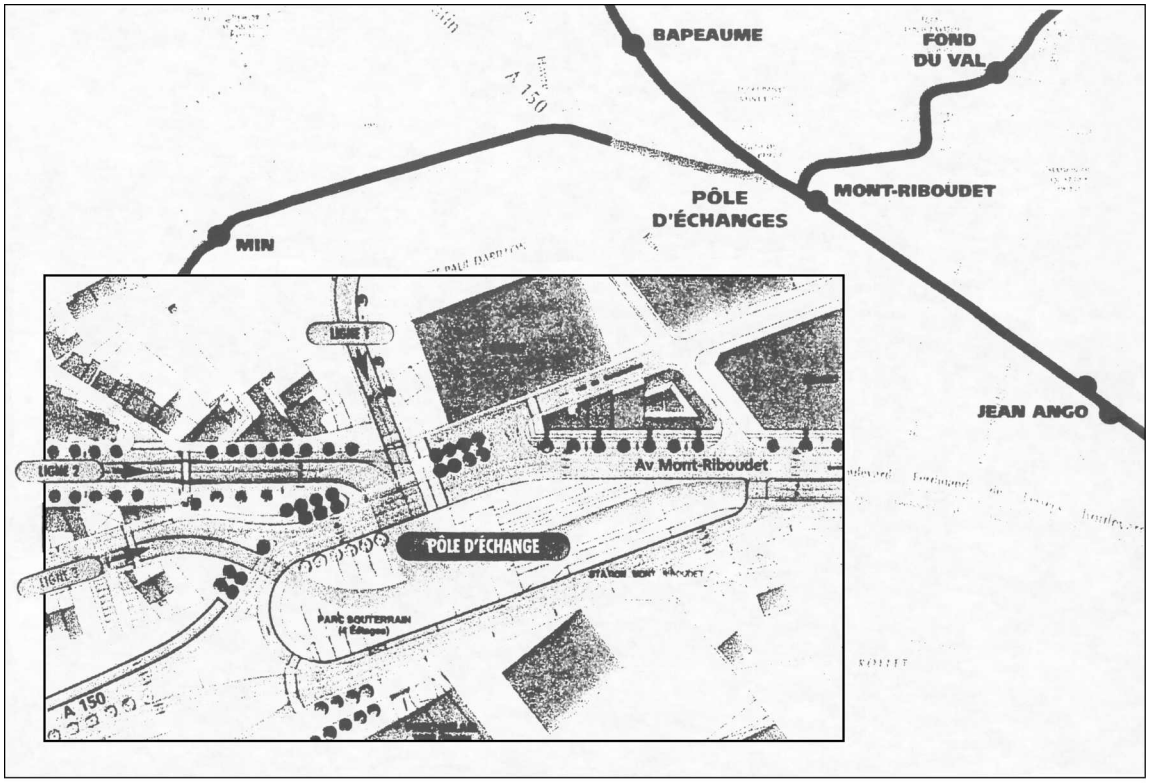

Figure 8: Central Bus Exchange