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TRANSFER STATIONS:

A challenge for the user, an opportunity for the city

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Abstract

In Santiago de Chile in 2007 a radically new integrated public transport system was implemented: the Transantiago. As most integrated public transport systems, Transantiago considered a considerable amount of transfers within the daily trips: from bus to bus and from bus to metro. The increase in the amount of transfers has been among the significant problems denounced by the users, creating resistance and dissatisfaction among them.

Thus, a multidisciplinary research project was set to classify the various types of transfer occurring in Santiago and identify the basic conditions that should satisfy the exchange points from a comprehensive perspective. The idea was not only to improve the transfer experience but also to use the urban buzz created by the pedestrian flows to support an urban sub-centre that could service and enrich the area around the transfer point.

This paper presents the analysis of a transfer point in Santiago analyzed from this multiple perspectives. The data collection included a register of the land uses in the area, the application of a survey to frequent travellers enquiring on preferences, follow ups at the transfer station, measurement of pedestrian flows and spatial modelling (VGA and isovists).

The results offer the possibility of understanding transfers both as significant parts of a trip and in their urban development potential. By understanding the public transport network and especially transfer points from this perspective, it is possible to first diagnosis and then offer recommendations for an appropriate design of these spaces.

Keywords: *movement economy, transit oriented development, urban flows, visual fields, public transport*

Theme: *Urban Space and Social, Economic and Cultural Phenomena*

1. Background

Historically, the issue of urban transportation and mobility in Chile has been approached from the perspective of transport engineering, with little or no coordination of other fields. The lack of consideration of the effects of public transport on urban space, as well as the limited understanding of users and their needs (beyond mere descriptions of the necessary conditions by which he or she is able to arrive at a final destination), have led to lost opportunities for establishing synergies that would strengthen and reinforce public transport as well as provide a better city, thus improving the quality of life of urban dwellers. Transantiago, an ambitious pioneering project implemented in Santiago de Chile in 2007 has fallen short precisely in this area. Although it has attempted to coordinate a bus and metro train system at a metropolitan scale it is lacking an integrated vision that considers the city. As such, the city has seen urban spaces, which instead of being strengthened by new pedestrian traffic, have been degraded by interventions that have cut off sidewalk and urban public spaces. At the same time, instead of taking advantage of the coordination between buses and the Metro system, users have been confused and squandered opportunities to benefit from the system's increased potential, due primarily to a lack of an adequate information system.

Although Transantiago has achieved the effective integration of public transportation in the city by combining the Metro system and bus operations in terms of fares and charging (common electronic Bip card), it has not achieved infrastructural, spatial or operational integration regarding the simultaneous services provided for any given transfer station. In fact, one of the aspects that has been most criticized and worst evaluated by users of the system is precisely the transfer between different modes of transportation. Despite not being well disseminated or very clear for the population in general, the concept of transfer stations has been well defined by academia, and has been recently subject to analysis. It is known that the stations at which multiple modes of transportation converge and transfers occur have particular characteristics that demand certain additional services and spaces.

In order to contribute to the understanding of this problem, during the past year a group of academics from the Schools of Architecture, Design and Engineering of the Universidad Catolica, in the framework of the Centre for Sustainable Development (CEDEUS), have been carrying out an interdisciplinary research. The study seeks to analyze a set of multi-modal transfer stations within the city's public transportation system (bus stops and metro stations) from a multidisciplinary standpoint: specifically, from the point of view of transport engineering, user experiences, and the spatial and urban conditions of the transfer stations and their surroundings. In this last point of view the space syntax analytic methods have offered specific advantages to understand ways of facilitating the interchange to the users (eg. to make the next stop and the coming bus visible from the Metro exit), adding value to the trip itself (eg. by adding commerce and urban services in the way from one mode to the next) as well as offering a more attractive social and urban atmosphere (eg. by offering sitting areas and urban amenities in the route).

2. Francisco Bilbao Metro Station

The station has a total of seven bus stops and two Metro exits (see Figure 1). Of the seven bus stops, one does not provide any service (7), while three others serve as pay zones during the peak hours of the morning and/or afternoon, and have barriers to provide order for the flow of passengers (2, 4 and 6). Stop 3 also has barriers set up, but currently does not operate as part of the pay zone. Following the first survey of the place, a brief analytical description from four points of view was carried out: land use, pedestrian flows, visual fields and commercial offer.

Figure 1: Bus routes and stops at the Francisco Bilbao Metro station.

2.1. Land use

The land use map of the surrounding area reveals a mainly residential sector, although immediately around the bus stops there is a significant presence of commercial and institutional (educational) buildings, and at a short distance there is a health center (see Figure 2). It is also important to point out that the Metro station is located directly next to a petrol station, which is situated on the southwest corner. On this corner, the petrol station seems to force the location of the Metro exit, which is very close to the street. The closeness of the exit leaves a strip of sidewalk that is clearly insufficient for this convergence of services, which includes a bus stop as well as the pedestrian traffic on the sidewalk itself.

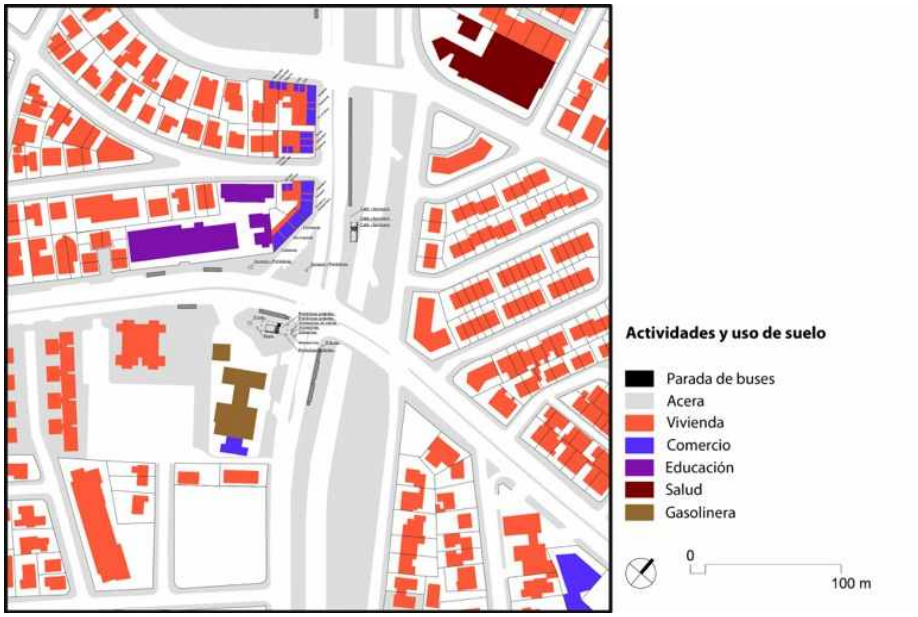


Figure 2: Land uses around the Francisco Bilbao Metro transfer station.

2.2. Pedestrian flows

In order to record the intensity of the pedestrian traffic flows, pedestrian flows was observed during five-minute intervals for one hour during the peak traffic hour in the morning, and another hour during the peak traffic hour in the afternoon, counting how many people crossed through virtual doors established along all of the sections of the possible routes within the surrounding area. This information was represented in GIS form, color-coded by red (intense traffic), green (medium traffic) and blue (low traffic). The representation of these measurements shows a high concentration of pedestrian traffic on the southwestern sidewalk, at the south Metro exit and in front of the petrol station (see Figure 3).

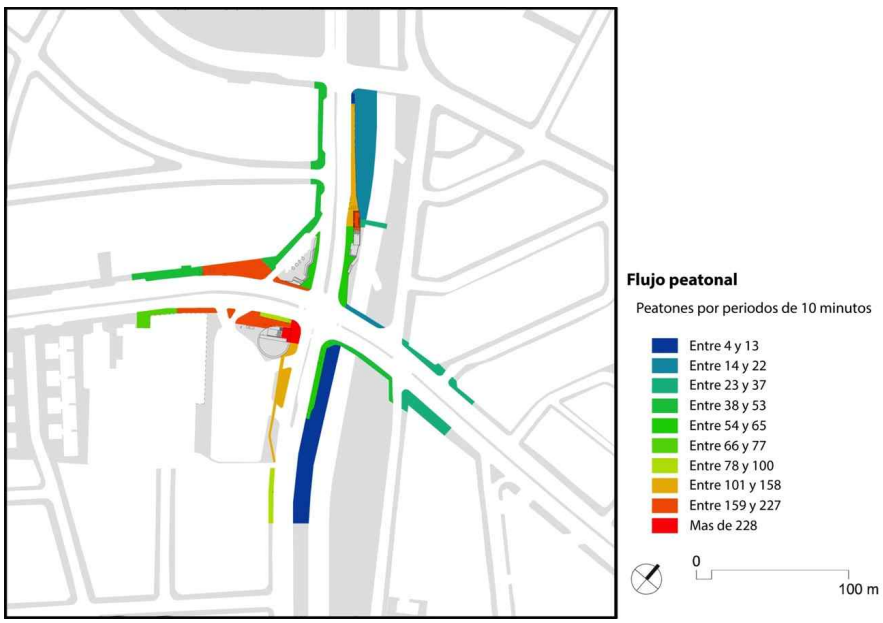


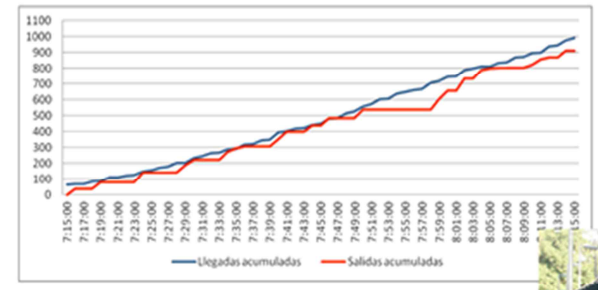
Figure 3: Pedestrian traffic in the area surrounding the Francisco Bilbao Metro transfer station

The high level of pedestrian traffic on this corner attracts street vendors, which provide a certain level of vitality to the area, but also create further congestion within the already limited space available to pedestrians. The narrow space of the sidewalk, together with the high pedestrian traffic flows and the presence of street vendors, are even further complicated by the presence of other elements of the urban environment, such as signs, fire hydrants and traffic lights. If there were another Metro exit, preferably on the northwest corner, the congestion would most likely be alleviated.

In order to go into more depth on the movements and flows, a series of individuals who got off the bus at the bus stop or who exited the metro station were followed. A total of 60 pedestrians were followed from the seven bus stops and the two metro exits, proportional to the flows observed at each of the virtual doors that had been established for observational purposes. All of these following activities are represented in Figure 4.

Figure 4: Shadowing of pedestrians at the Francisco Bilbao Metro transfer station.

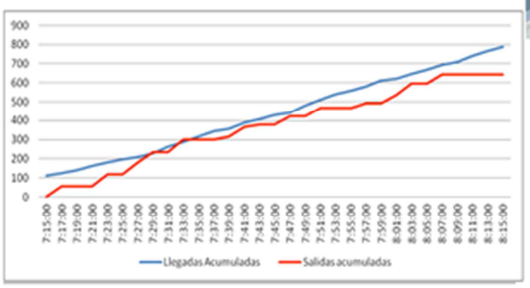
In addition, arrival and departure profiles were made of stops 1, 2 and 3, in order to evaluate the level of service regarding intervals and frequencies of bus arrivals and departures, and to calculate the length of the waiting lines (see Figure 5).



- Maximum capacity: 192 pax
- Pax Average: 52 pax
- Average fill: 27%

- Headway 501: 6 min
- Headway 504: 4.5 min

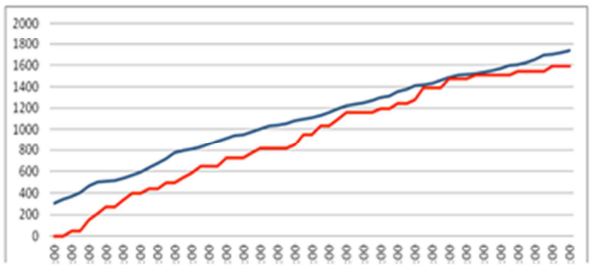
(a) Profile of arrivals and departures at Stop 3



- Maximum capacity: 420 pax
- Average fill: 18%
- Pax average: 75 pax

- Headway D08: 5 min
- Headway D15: 8.3 min

(b) Profile of arrivals and departures at Stop 2



- Maximum capacity: 840 pax
- Average fill: 18 %
- Pax average: 150 pax

- Headway C01: 4.6 min
- Headway C05: 5.3 min
- Headway C07: 4.5 min

(c) Profile of arrivals and departures at Stop 1

Figure 5: Profile of arrivals and departures at three bus stops

2.3. Visual flows

The study of the transfer station also involved a VGA analysis (Visual Graph Analysis). The open space of the area was modeled using Dephtmap software programme This programme establishes an artificial grid throughout the entire space to be analyzed, quantifying how visible each of the cells is from all the rest of the cells in the system. The results are displayed over the same gradient of colors described for the representation of pedestrian traffic flows: in red are the cells that provide the highest levels of visibility, green represents the intermediate levels, and the least visible cells are represented in blue.

The analysis was performed with all of the visible open spaces, including the streets (considering that both sidewalks are visible across the street), but later the streets were eliminated from the analysis, as they are not a space where pedestrians can stand still and observe. The results of this modeling are presented In Figure 6, showing that the most visible spaces in the system are precisely those that are closer to the edge of the streets, in addition to the small traffic islands in the middle of the pedestrian crossing (see close up in Figure 7). These

traffic islands offer the best visual perspective of the buses that are arriving and departing, transforming them into decision-making spaces regarding the best route to take, as well as an incentive to take a short cut in the way of the diagonal crossing.

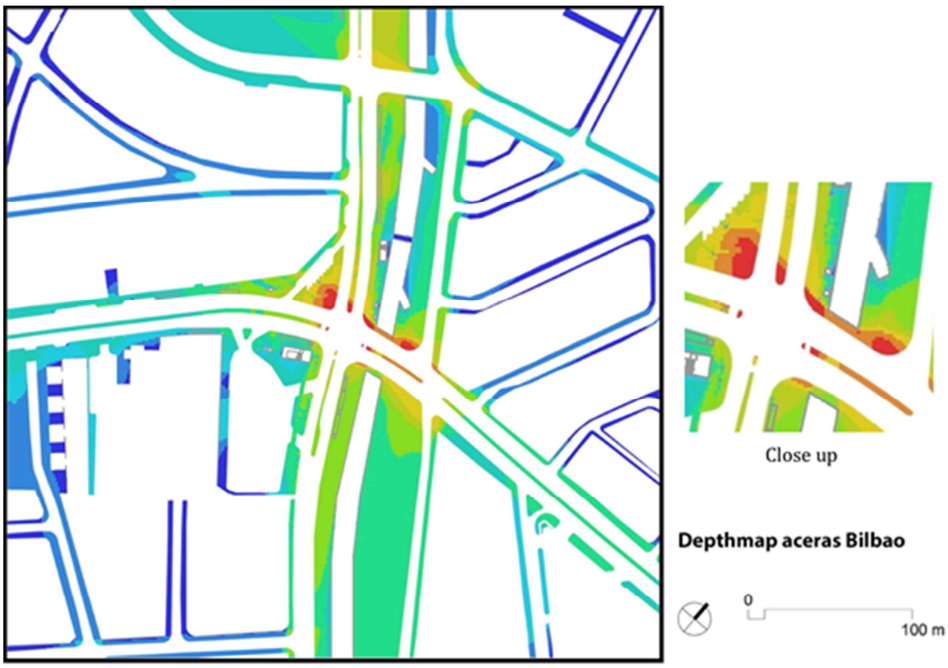


Figure 6: Visibility analysis in the public space around the Francisco Bilbao Metro station.

2.4. Commercial offer

Finally, isovist analyses were performed from all of the stops and metro exits. The following graphics show a color sequence (from the warmest to the coolest colors) that represents the first, second, third and successive moments, from the two exits of the Francisco Bilbao Metro station (Figure 7).

Isovists, Metro Bilbao north exit Isovists, Metro Bilbao south exit

Figure 7: Isovist analyses from the north and south exits of the Francisco Bilbao Metro station

In the case of the north exit of the Metro, the isovist analysis shows that the visual field allows a person exiting the station to only see one bus stop, while in the case of the south exit the visual field allows to see the other Metro exit as well as bus stops 3 and 7. Due to the orientation of both exits, neither allows for the possibility of immediately visualizing the totality of the transfer area. The following chart provides a brief summary of the visibility between the metro exits and/or bus stops. Among these, bus stops 2 and 5 have the greatest visibility of the transfer area as a whole (Figure 8).

		Paradas y/o salidas									Promedio visibilidad hacia otras paradas
		Metro Sur	Metro Norte	Parada 1	Parada 2	Parada 3	Parada 4	Parada 5	Parada 6	Parada 7	
Punto de observacion [parada o salida]	Metro S		1	2	2	1	1	1	2	2	1,50
	Metro N	2		2	2	2	1	2	3	3	2,13
	Parada 1	1	1		1	2	2	1	1	1	1,25
	Parada 2	1	1	1		1	1	1	1	1	**1,00**
	Parada 3	1	1	2	2		2	2	2	2	1,75
	Parada 4	1	1	2	1	1		1	2	2	1,38
	Parada 5	1	1	1	1	1	1		1	1	**1,00**
	Parada 6	1	2	1	1	2	2	2		1	1,50
	Parada 7	1	1	1	1	2	2	2	1		1,38
Promedio visibilidad de la parada o salida de estaci?n desde otras paradas		**1**	**1**	2	1	2	2	2	2	2	

Figure 8: Visibility analysis between metro exits and bus stops at the Francisco Bilbao station.

It was also of interest to measure how many linear meters of commercial activity in the area it is possible to see when coming out of the metro, or when getting off a bus. The total amount of existing commercial frontage was 178 ml. The calculations showed that bus stop 3, the North Metro exist and bus stop 5 were the ones that provided a better view of the commercial frontage (106.0, 97.0 and 92.1 meters respectively) followed by bus stop 4, 2 and the South Metro exit (that provided 80.8, 35.3 and 10.8 meters of commercial frontage. The other three bus stops (bus stops 1, 6 and 7) did not allow for commercial frontage vision.

3. Final Remarks

In light of the analysis, it was observed that the diversity, and sometimes collision, of existing elements (sidewalk, ciclying routes, urban furniture, vendors, commerce, access to properties and others) is not considered when designing the transfer stations. Behind the term "transfer station" there is no concept that identifies it as a spatial and functional unit determined by the transitions between medias. Therefore the lack of appropriate design comes as no surprise. It is a complex space whose functions overlap with many other of the city at different scales, and, therefore, it requires a special clarity and coherence. Such clarity and consistency was not observed in the analyzed case.

First, the transfer from one transport media to another requires certain attributes from the place and its environment, in order to fulfill its function; and second, it generates a series of impacts that are susceptible of becoming positive attributes. The study in the Francisco Bilbao transfer station shows that while the space has not been specifically planned to perform the

transfer, despite all the hardships and traffic and pedestrian congestion that it causes, it has been instrumental in shaping the place as a new center. It has become an area of greater intensity of use strongly linked to the emergence of street vendors, but also to a commercial dynamic providing services to the residential area around.

Conclusions can be summarized in the following:

First. From the perspective of urban design, a transfer station should be understood as an entity in itself (both spatial and functional) with its continuities and overlaps with the city in spatial terms (cross streets, sidewalks, bus stops, underground station, and others) and functional (cars, bikes and other transport modes, providing information, economic activities, etc.). A recognizable spatial unit for pedestrians as well as for other modes of transportat that pass through.

Second. The design of transfer space should answer to the transfer concept and incorporate the requirements defined by the frequency of the buses and the priority trajectories of the users.

Third. Some design criteria arising from the observations of the behavior of pedestrians and visual fields are the following:

- The contact points of the Metro stations with the buses require a space for passenger orientation and the decision of the next leg of their journey.
- This space ought to have the information required to make decisions.
- The information ought to be presented in a consistent and integrated way between bus and Metro services. In addition, this information must be located in the user decision points in the way from the car to the Metro bus, or vice versa.
- This space ought to offer a visual field that allows the user to cover all choice points (bus stops, pay zones, Metro exits, crosswalks) to take the following means of transport.
- The paths between the two transfer points (sidewalks and road crossings) should have pedestrian priority and provide pedestrian safety assurance. It should have a clear and readable design not only for the passenger, but also to the car or bus drivers. During the transfer, the user is "in" the same trip, in fact, he is paying one ticket and is protected by a life insurance policy.

Fourth. The opportunity to conceive (plan and design) a public space of quality along with the transfer functional space. Besides being a functional space, transfer stations are privileged points of information and commerce (particularly street vendors) and social, which enriches it as public space. The transfer space design ought to take into account this reality to anticipate situations and points of conflict. Among the criteria to be considered for the design in relation to this point, it is important to mention:

- The design of the sites and media information
- Control of physical and visual distances between commercial facilities around the station.
- The presence or absence of trading "in the way" that mediates between the commerce and transfer.
- The relationship between the space for the bus stops (depending on type) and the space of the street passerby
- The urban furniture design transfer points (bus stops) as well as potential points of

pause or wait.

- The ranges of each of bus lines that stop at the stops that belong to the transfer station should be regulated, it is recommended to use real-time information. In this way the handling of the spaces in the stops could be more appropriately dimensioned.
- The location of places in order to save the bike and thus include it as part of the transfer station.
- The location of a place where buses can stop at the end of its travel to and carry out the necessary activities without obstructing the stops.

As noted in this study, the basis of a good transfer station lies not only in technical aspects but also social. The acceptance and adoption of a transport system involves a community. Apart from technical and functional aspects, it is important to know and understand the needs of the users (passengers and inhabitants of the area). An integrated perspective to the transfer stations would offer many advantages to the users of the public transport system and to the city. Mainly, by understanding the needs of information and the common everyday needs of the passengers and providing them in the infrastructure of the transport system, much would be gained by all.

4. Acknowledgements

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