Planning Underground Urban Space – Where, When and How?

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ABSTRACT

Making underground space is unlike planning at ground level – the space is enclosed, relatively expensive and difficult to modify once constructed. Pedestrian behaviour is different in underground space because of the absence of significant markers and orientation. High cost and very great difficulty in making modifications to underground pedestrian systems once they are established makes it important to get the planning right in the first place. Underground urban space is typically connected to development at the ground level, resulting in a unique dynamic relationship between below- and above-ground space. Finally, complex relationships of ownership, access and linkage raise problems of distribution of costs and benefits. Therefore, we need a rigorous method for making plans and evaluating their economic and social effects. This paper sets out a framework for planning and evaluating underground urban space, illustrating the importance of each planning component with examples.

Among the topics that need to be considered are the following: 1–How can we estimate future pedestrian flows on underground corridors, in the short- and long-term? 2–What are the effects of later phases of development on the earlier phases? 3–What is the relationship between above- and below-ground pedestrian flows? 4–How do we separate and evaluate flows for commuting purposes, shopping and leisure? The presentation will include examples from studies carried out in various underground systems.

1. UNIQUE CHARACTERISTICS OF UNDERGROUND SPACE AND IMPLICATIONS FOR PLANNING

Underground space is enclosed and closed-ended. For technical reasons, underground space is isolated from the outdoor environment with permeable barriers. As a result, conscious decisions are made about where such space should be accessed and the form of access–stairway, escalator, elevator. Compared with almost all ground level walking systems, underground systems have relatively few points of egress. Nearly all developed underground systems give priority to egress through buildings, rather than directly to the outdoor environment, adding an additional layer of spatial connections. The system is then heavily dependent on the land uses and structures that channel access to the underground walking system.

Office and retail uses are the biggest generators of pedestrian traffic in underground systems (Zacharias, 2000a). In figure 1a, pedestrian trips beginning at Metro station McGill are shown, with a concentration of stops in shops near the exits from the metro station. Similarly, an office building also generates distinctive flow patterns with a high concentration of stops within a walking range of about 300 m.

The prediction of these preferred walking itineraries from important point sources of pedestrians is a major challenge of the research work. But the characteristic form of these walking patterns strongly suggests it is predictable.

A second important issue concerns the connection between the surface and the underground. There are multiple possibilities for the vertical exchange: 1–a stairway/ramp between the ground and the first
floor immediately below; 2—a two-way escalator with accompanying stairway; 3—a stairway and an elevator. In addition, the height differential between floors may vary, possibly adding extra steps to climb or the stronger sensation of going underground.

![Diagram](image)

Fig. 1. Tracked pedestrians leaving the metro station McGill in Montreal have definite preferences of pathway and destination. Similarly, office-workers leaving the Place de la Cathédrale office building at noon have preferred pathways and tend to visit only certain parts of the Underground system.

Finally, the land uses and surface activity patterns intersect at certain points with the underground. Due to a certain independence of internal dynamics in the case of the surface activities, the connections can become crucial for adequate delivery of visitors with common goals and behaviours. A failure to adapt the plan to accommodate the particulars of the local environment can lead to long-term problems that resist easy resolution. A case in point is the 1970s project at Les Halles, now needing to be rebuilt and the subject of public competitions and a public consultation, amidst a wider debate in France on a number of social issues (Actualité, 2006).

The original physical plan included a regional rail system hub under the existing lines of metro, all buried beneath a densely built, historic core area. The removal of the Baltard market buildings following the move of the market to Rungis in the 1960s freed up a substantial piece of land. It was thought to make the link between a new hub of regional rail and Paris metro, linking the lively surface environment with these transportation systems via a shopping and recreational complex. The project was built in two main phases, the Forums. Forum I introduced a pedestrian circulation system on three levels that failed to function on two. Forum II thought to avoid this problem by introducing one major circulation level, extending the pathways with loops and turns. But pedestrians are not evenly distributed in this underground shopping complex, leaving long elevations empty or under-used, while the main corridors are heavily travelled.

In the case of Les Halles, the failure to transfer pedestrians from the ground to the first level down, meant that the flows were channeled on escalators that made the transition directly to the main concourse leading to the metro lines and RER. Here, there is a clear connection between the transportation hubs, along a straight line running from the main RER station entrance through the courtyard of Forum I and continuing to the Cour Carrée, where a major gate to the metro is located.

In fact, the original planning idea, that we now see to be faulty, cannot be fixed except at enormous cost. The transportation system must continue to run while the project is disassembled and reassembled around it. Such a task would be gargantuan and full of risk. So the issue that remains is one of finding remediative measures appropriate to the case.

All vertical circulation poses serious challenges for planning. In shopping centres, it has been found that there is resistance to changing levels unless there is a prevailing reason to do so. Simple
exploration would appear to lead to a sharp decline in travel between floors from travel within floors. In fact, the study conducted on Plaza Alexis Nihon Montreal appears to bear this out by supplying figures on the proportion of over 700 visitors who actually travelled to other floors from the floor of their entry to the three-level shopping mall (Zacharias, 2005; 2000b). Approximately 41% of visitors actually made one change of level, even though the shopping mall is “zoned” vertically to distribute the visits. The points of exchange become very important, with sharp differences in use levels among multiple points of exchange between pairs of floors.

Fig. 2. Pedestrian volumes at street level and at –3 level (with flows on the intermediary floors in the vignette).

These illustrations of characteristics of underground systems requiring an adapted approach to spatial planning leads to a call for a systematic approach. The complexity of the situation calls specifically for a step-by-step approach, to build knowledge of the internal dynamics and thus of its eventual value and use in the city.

At the same time, the called-for approach is unlikely to be implementable within the current institutional arrangements, given the difficulty of overseeing and controlling underground space as a separate layer in the city. The barriers of property ownership and access make it difficult to implement desirable linkages, except through long-term negotiation and on a project-by-project basis. Failing the introduction of a mechanism for the evaluation, approval and funding of infrastructural improvements to the underground, the evaluation procedures can still be used to supplement negotiations between private owners, adjacent developments and between private parties and the local government authorities.
2. DECISIONS ADAPTED TO THE UNDERGROUND

It is suggested that both a ‘plan of potential underground development projects’ as well as an ‘evaluation procedure’ for individual projects be used to perform our projections, basic projects and planning. In detail,

1. Plan of potential underground development projects
2. Assessment of transport-related movement
3. Assessment of overall projected pedestrian flow levels
4. Commercial use potential
5. Impact on the existing network and commercial space system
6. Space and facility standards for the project
7. Link requirements
8. Integrated management plan

1. Potential underground development projects can be identified through careful examination of the city fabric. These public and private initiatives are mostly predictable given the cumulative outcome from existing cities that have developed underground systems. These potentials in the environment can be visualized as a system. Note that such an instrument is also a pro-active construction on the environment, the moreso for being realistic in terms of its reliability as a scientific document.

2. Assessment of transport-related movement – Transport-related movement can be relatively easily estimated from known walking patterns. Shopping facilities that deviate considerably from these desire lines for travel could be considered private initiatives, while a main corridor carrying commuters might be considered in part a public good. Such definitions will help clarify how objectives are being met and whose interests are being served.

3. Assessment of overall projected pedestrian flow levels – The commercial and residential uses in the environment of the walking system will generate movement within that system, as well as on surface streets and sidewalks. The next task is the projected distribution of that generated pedestrian activity, over the system of corridors, sidewalks and streets. Using known parameters of behaviour in relation to spatial layouts, it is possible to project movement with fair accuracy over a given system (Zacharias et al, 2005). This provides a hierarchical system of movement, typically, over a particular
path layout, and in relation to a surface system with somewhat different spatial parameters – all in interaction. Additions to this system can have significant effects, as outlined above. The movement system can then be understood as a spatio-behavioural construct of a movement system together with a movement pattern.

4. Commercial use potential – The movement hierarchy, including the separating-out of transport-related movement, provides a relatively stable structure of economic values associated with it. In general, such systems contain movement volumes as high or higher than any recorded volumes on the streets in those cities. While the level of pedestrian flow cannot predict the type of use for the most part, rental values can be closely related to the pedestrian volumes. The flows themselves may suggest concentrations in space at particular locations, either in multi-storey structures or in extensions from a node. The opportunities for this kind of development are clearly imaginable from the projected flows in particular locales. This comprehensive view of the commercial centre makes it possible to see all the benefits or harms associated with a project and how they are distributed.

5. Impact on the existing network and commercial space system – An assessment of impact of a particular underground project in the context of already built-up urban area will require an estimation of the pedestrian flow through the project. These flows will be determine for the types of uses that can be sustained. Also to be taken into account is the competitive structure of the whole system of shopping facilities. When centres are approximately the same size, all else being equal, they can compete effectively and divide the market relatively equally. However, a very large centre, relative to the existing ones, might also draw visitors away from other centres. Similarly, a project can be hampered by its geographic situation and connections to major public transport facilities. The above cases illustrate that there are positive and negative externalities in most underground projects, but the net contribution is what we want, besides being able to avoid mistakes.

6. Space and utility standards for the project – Once the requirements of pedestrian flow and facilities are known, from a comprehensive assessment of the whole system, then it is appropriate to consider the space requirements. The analysis of system dynamics and overall space needs will drive the distribution of space and the delivery of underground space to the market. The distribution of this space on the property should also be of some concern, since it must correctly link with other projects either existing, in planning stages or imaginable. To avoid the real possibility of breaks in infrastructure due to independent operations, some coordinating technical role is mandatory. This becomes all the more crucial when topography or multi-level systems are involved. It is likely some margin can be imagined in terms of the distributions above and below ground, their volumetric characteristics and other architectural features. What is important is a functional connection and a logical ensuing circulation system within private space, reconnecting in logical ways with the surface public environment.

7. Link requirements – Thought must be given to the characteristics to be given particular linking tunnels between major structures, particularly where there are no commercial facilities. In the case of shopping centres, there are efforts at the level of the centre to give it particular character, often interpreted in terms of finishes, lighting and dimensions. For spatial orientation purposes, but also to enhance the experiential environment of interior space, consideration should be given to the dimensions, spatial form, colours and lighting. Anonymous corridors are not to be built where the system becomes at all complex, like those that exist in some major cities.

8. Integrated management plan – The projection of changes, anticipated, desired and avoidable, is certainly a tool that proves indispensable to the projection of a successful future state. But it is also a useful tool for projected improvements to operations in the system. Much of such a system will ultimately be privately owned and operated and should be allowed to evolve and develop autonomously. The role of a civic authority is to ensure that seriously damaging projects are not approved, and that the whole continues to prosper and get bigger. This simple imperative makes the
task of assessing the worth of individual projects somewhat easier. It might be tempting in this sense to consider other objectives that could be realized as part of an integrated management plan. However, it could be too tempting to do so, when what we really want to promote is vitality of the whole system. Therefore, an integrated management plan is for the purposes of expansion and improvement, particularly of the public components of the system, along with estimations of opportunities as well as resolution of conflicts. It should be noted in this regard, that the necessity of creating a harmonious, safe and useful system makes this level of intervention highly desirable. The role of the public bodies, then, is to promote vitality, diversity and self-generated growth.

3. CONCLUSION

Case histories confirm the importance of certain salient characteristics of underground pedestrian systems that are at variance with similar systems on the ground. The open-ended surface systems have multiple possibilities for linkage, while underground connections must be planned and are never as easily implemented as surface or above-ground systems. The possibility of an independent underground system, differently laid out than the surface system raises the possibility of synergies and growth as well as risks. It is through better understanding of the dynamics of such underground pedestrian systems that we can plan underground systems, or evaluate plans in order to make informed adjustments.

A set of sub-studies are suggested to help understand the local dynamics of an underground facility and to assist in the decision-making process. It is a truism that projects concerning underground space and to a lesser but still important extent, pedestrian systems overall, under-achieve objectives and often contain planning flaws. It is to the end of reducing the error factor in planning that this work is dedicated.

Finally, it will be seen that many of these studies require a quantification of movement, land use and economic effect. Methods for collecting data in these environments, with procedures that are appropriate to the nature of those environments, are available and discussed elsewhere in the literature.

REFERENCES


