

Planning the use of underground space

Explosive growth of cities in developing countries, shifting demographics and aging infrastructure in older cities – coupled with the demand for improved liveability and environmental protection – are creating a strong demand for new underground infrastructure. As this happens, the impact of previously unplanned underground space use rapidly becomes clear – expensive relocations of existing facilities are required, access to favourable geological conditions may be blocked and underground transport facilities are forced progressively deeper to find suitable alignments.

“Although much careful study has been given by trained experts to the preparation of plans for the rebuilding and extension of large cities and the laying out of new towns, and to the development and improvement of street systems so as to provide for present and future surface traffic and to best serve the convenience, health and welfare of the people, but little thought has been given to the subterranean street. In only a very few of our large cities has any attempt been made to plan subterranean streets or to chart the structures which they contain”.

*George S. Webster
Annals of the American
Academy of Political and
Social Science (1914)*

To avoid such problems, planning for urban areas must go beyond the conventional two-dimensional arrangements of surface facilities and consider the full three-dimensional interactions between the built environment and its supporting infrastructure. The underground as a spatial asset needs to be clearly understood by urban decision makers if it is to achieve its full potential in adapting cities to the many challenges that will be faced in the coming decades.

Lack of planning leads to suboptimal use of underground space

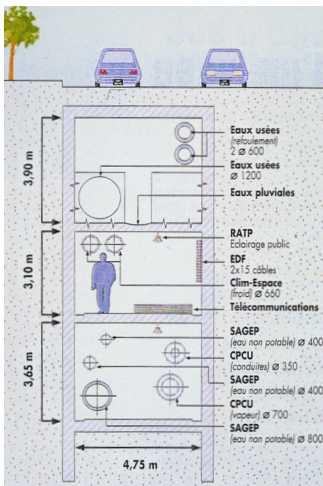
Conflicts with prior uses (often of lesser value) and unappreciated impacts on other underground resources often make the overall use of underground space in a city or regional suboptimal. This frequently occurs because the basic resources provided by the underground, i.e. space, materials, water and energy,



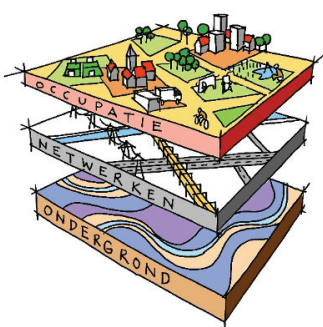
Montreal's underground network – a set of city-enabled, privately-developed underground connections that ties much of the city center into a climate-protected, traffic-free and vibrant pedestrian zone. Source: Observatoire de la Ville Intérieure



A 1918 photograph of the utilities beneath Wall Street, N.Y. - showing the already congested maze of underground utilities



Cross section of a multi-level utilidor in Paris – concentrating various utilities into a compact multi-functional underground space. Source: SEMAPA



A layered approach to urban and land planning. Source: Ministry of VROM

are considered individually when deciding on the use of underground space. These four resources often fall within separate policy categories and therefore different government departments. As a result, the decisions on the use of underground space are made from a mono-functional rather than a broader perspective. Moreover, in most cities, there is almost no coordination between the different users of underground space itself. The rule is typically “first come, first served”. The “first come” user takes the most favourable place for his/her particular needs (location, geological conditions, easier construction, etc.), without any vision for the possible future uses of underground space at that location. Multi-functional structures underground are very infrequent. The result is a chaotic placement of underground structures which makes much more difficult the realization of new facilities and/or infrastructure and prevents a harmonious and sustainable urban development. It is thus necessary to come up with an integrated, multi-disciplinary, approach to the use of underground space if we are to use it optimally and preserve the potential of underground space to solve problems for future generations as well as our own generation.

Current practices in planning underground space use

Several current approaches to planning the use of underground space have been identified. Some examples of these approaches are briefly presented below.

Arnhem and Zwolle, two cities in the Netherlands

In the Netherlands, a new model of analysis has been introduced for urban and land planning. This model consists of identifying three layers in spatial planning: the occupation layer, consisting of plot oriented developments (e.g. housing and offices), the network layer, consisting of all networked functions (e.g. road and rail infrastructure), and the underground layer, consisting of all subsurface functions (e.g. storage of water). By analyzing these layers and by looking at the interaction of these layers, in theory, planning could incorporate the underground and its functions and uses and take decisions on future use and developments from an integrated perspective. This integrated planning approach and the identification of underground space as an important component of planning has encouraged specific inclusion of the underground in city planning in the Netherlands. For example, in the City of Arnhem, the use of underground space has been supported and promoted by the City Council due to the shortage of space for development and, at the same time, the need to maintain and enlarge the spatial qualities of the city. All parties involved in the process of city planning in Arnhem, both public and private, now need to specifically consider underground space use in their planning. In a different approach, the City of Zwolle has created a “Vision on the Underground of Zwolle”. This document comprises a complete analysis of the underground space beneath the city. It

gives an overall vision from the perspective of 2020 and it then identifies four areas within the city boundaries in which, using the layer model approach described above, further in-depth analysis is to be made to identify opportunities and development tracks. The vision document was approved by the City Council in October 2007 and, although it is not a legally binding document, it is the first time that a city in the Netherlands has developed such a strategic policy document in which the vision concerning development of the underground is laid out.

City of Helsinki, Finland

The City of Helsinki in Finland is another example of a city leading the way in terms of planning the use of underground space. Helsinki has created an Underground Master Plan for the city in terms of underground space use. The aims of the master plan are to not only show the current use of underground space but to reserve space for future uses. The master plan has five categories of underground space use: (1) community technical systems, (2) traffic and parking, (3) maintenance and storage, (4) services and administration, and (5) unnamed rock resource. It also distinguishes four different planning levels from projects to provisional space requirements. One of the interesting things to observe in this case is the fifth category “unnamed rock resource”. The bedrock beneath the city has many opportunities for usage. But there are also areas which are less likely to be used or cannot be used from a geological point of view. The areas that are most likely to be used are identified as potential usage areas, although no plans yet exist or specific uses identified. This approach illustrates the need to connect present use, planned use and possible future use with each other in the planning of underground space. A second interesting observation is that the Helsinki Underground Master Plan is a legally binding document in terms of urban planning. In that sense, it goes further than the example of the City of Zwolle. It also goes further than the City of Arnhem in that it shows where underground space development will take place rather than simply making it obligatory to consider the use of underground space in development schemes.

Extract from the Singapore’s Economic Strategies Committee Report (01/02/2010)

“We would like to develop an underground master plan to ensure that underground and above ground spaces are synergized and optimized so that we have more space for Singaporeans and give the sense of space to Singaporeans.”

Ms Grace Fu, Senior Minister of State for National Development

Shanghai, Beijing and other major cities in China

The City of Shanghai in China provides an example of how a city can run into problems if no planning regulations exist. The use of underground space in Shanghai, as in many other Chinese cities, has been growing rapidly in the

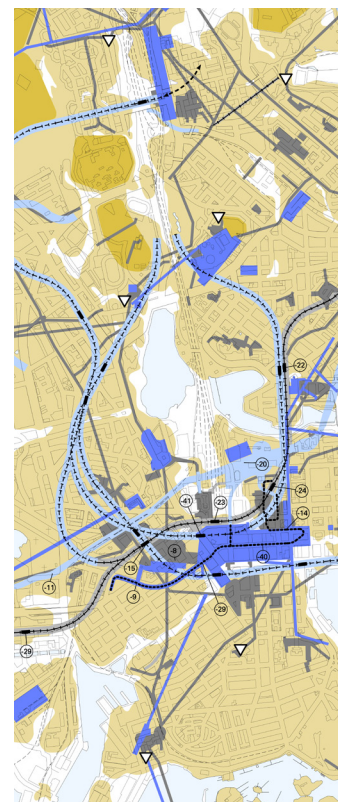
Extract from the Shanghai Daily News (27/04/2005)

“Setting strategies for properly utilizing underground space is crucial for the city’s future development”

Mr. Huang Jianzhi, senior city government official

“The government should have created an underground plan before so many high-rises were built”

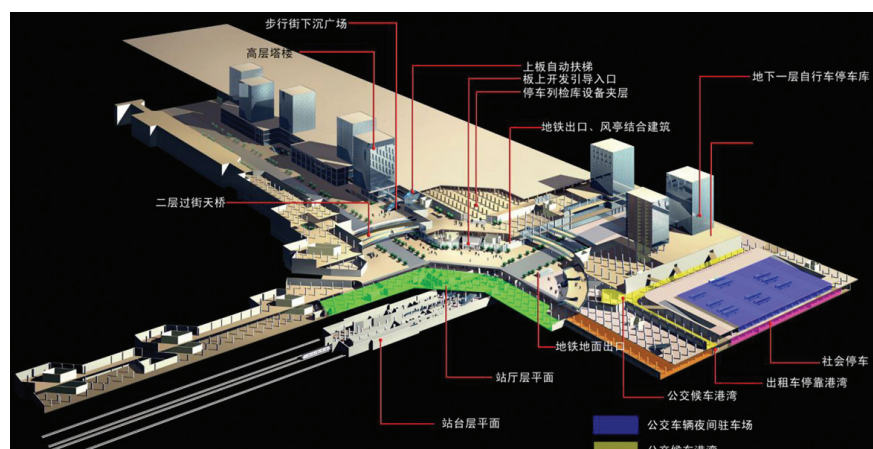
Mr. Yu Mingjian, senior engineer with the Shanghai Engineering Design Institute



Space reservation in underground space
- Helsinki



last two decades but conflicts with prior uses can cause major difficulties. For example, city planners have been forced to divert the alignments of planned metro lines because of recently constructed building foundations extending deeper than the expected 16 meters below grade. In Shanghai and in Beijing, local regulations have now been put in practice to coordinate the use of underground space and to prevent spatial conflicts by regulating, notably regarding parking and commercial uses, the amount of underground space property developers can use under high-rises. Nearly 20 cities in China now have plans compiled for the use of their underground space. The plans show the size, layout, function, development depth and timescale for planned projects.



Underground space integrated design and use: Guogongzhuang Station of Metro Line 9, Beijing China – comprising 200,000 m² of underground space (Courtesy X.D. Shi)

Can we really afford to go underground without vision?

For underground space use to remain a societal asset, we need to plan and manage its use, just like any other asset. If this is not done, its greatest benefits will prove to be short-lived and it will eventually cease to be an effective instrument for the support, redirection and sustainable development of urban areas.

About ITACUS

ITACUS sees it as its mission to advance the awareness and thinking on the use of underground space through the creation of a worldwide dialogue. The committee will fulfil its mission in a pro-active manner, furthering the cause of underground space use within the context of societal needs, environmental concerns, sustainable development and climate change

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