



Contents lists available at ScienceDirect

Tunnelling and Underground Space Technology

journal homepage: www.elsevier.com/locate/tust

Architecture of underground spaces: From isolated innovations to connected urbanism [☆]

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ARTICLE INFO

Article history:

Received 3 September 2015

Received in revised form 31 December 2015

Accepted 5 January 2016

Available online xxxx

Keywords:

Urban underground space

Architecture

Change of paradigm

The living

Motion

City reorganization

Urban intensification

Opportunities

Tools

Zoning

Mixed uses

ABSTRACT

This article provides an introduction to an architectural approach of subterranean space, presenting its properties and principles of development. It then analyzes some subsurface experiences of the 20th century and, by looking at their successes and failures, shows how a renewed human and dynamic vision could help move from developing isolated structures towards a connected form of urbanism. Such a transition would provide an adequate response to the challenges of modern metropolises, for instance in the Paris area. On the strength of these realizations, a national transdisciplinary research program was deemed necessary and this is how *Ville 10D – Ville d'Idées* came to be in 2013. This article thus recaps the history and reflection that led to the creation of the Ville 10D project, and explains how it emerged as a systemic approach to subterranean development.

Method: Conception and development of a change of paradigm: consider the living and motion as primary, unifying agents between the underground and the city above it; play with and act on the subsurface in order to reinject mixed uses and complexity into the city through a systemic approach of the underground in the urban eco-system.

Method: Creation of a research project whose organization reflects these concerns: in order to take the living into account, make the study as cross-disciplinary as possible, mixing competences and points of views.

Method: Four-fold organization – socio-economical, environmental, psycho-social, cognitive (knowledge and management of the underground) – corresponding to four main themes plus two transversal themes (legal and urban planning). Unfolding in four stages of 18 months each, these thematic approaches are casting converging light onto token sites chosen for their diverse typology. Around a hundred professional players are involved in the Ville 10D project.

Study results: Beyond the data gradually obtained through the project studies themselves, and without anticipating those to come, the first results so far have shown a growing awareness of and interest in the reality of underground potential. There has been a genuine gradual involvement of the development players, researchers and academics in elaborating the project.

Study results: For us, gaining support from the players is an essential stake to “unlock” the underground in the minds first, then in reality thanks to tools built by Ville 10D in all the fields of development.

Conclusion: Research reports are issued upon completion of each of the stages and posted on the website <http://www.ville10d.fr>. We are planning to present and publish the final reports at an international colloquium in 2017.

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1. Introduction

In contrast with aerial space, which is pre-existing, transparent and immaterial, underground space (apart from natural caves)

only exists if it is dug by man and his tools, and thus only as it is “invented”, so to speak. This specificity could make it a dynamic space connected to action and to the living. In each cavity that is hollowed out, there is, originally, humanness.

Is this human, dynamic dimension found in our subterranean city spaces or have they been frozen in their progress, at some stage, left soulless and unfinished? If the human, dynamic dimension fails to put its mark on underground development, if those

[☆] This paper is an invited discussion contribution to the Special Issue on Underground Space Use: A Growing Imperative.

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spaces remain limited to servicing, to a sort of enslavement of the subsurface, isn't the city depriving itself of a powerful opportunity for change?

This article raises several questions: Is there a specificity to subsurface space development beyond the rules of surface development? Is the underground a place apart, outside the city, or could it be advantageously seen as an integral part of the city? And finally, couldn't the inclusion of that dynamic and human dimension be an opportunity for the city?

Subsurface urbanism is a rather new concept, and there are hardly or no appropriate tools coordinating the various fields of expertise involved. They have to be invented so that urbanistic commissioning can exist, and that metropolises engaged in sustainable development may learn how to evolve with and through it. It is the purpose of the national research program *Ville 10D-Ville d'idées* (see [Illustration 1](#)).

2. Components of the quality of underground spaces

2.1. Differences and similarities between underground and overground spaces; meeting man's needs in relation to a space

2.1.1. Human needs in relation to a space

To be pleasant, fit to live in and desirable, a space, whether dug out or erected, must guide the senses and meet a certain number of needs of its visitors in terms of location, orientation, vistas, volume and scale, quality of lighting (natural or artificial), airing with or without plants, as well as sonic ambience. These are as many essential needs that above-ground constructions often neglect, over-confident in the visual and physical benefits they derive from their relationship with the exterior, the street and external space, which help make even unfit spaces acceptable.

The same does not apply to underground constructions, for which the public will be more demanding because of the rather negative fantasies attached to the subterranean and the fact that it is apprehended on the basis of feedback from its current uses, which fall short of its full potential, limiting it to a service area.

Fitted underground spaces must absolutely evolve to meet people's needs in relation to their sense of space.

2.1.2. Differences between underground and overground spaces

Overground space and underground space are opposites: the first is empty and the latter is solid, the occupation of the first is natural and spontaneous whereas setting up home in the latter is a deliberate effort. And yet, when an underground space is created, why would 'nature' be excluded from it? Air flows there, water flows there and, if there is light, plants grow there. The underground is not fated to be a buried space. The underground – or the Under-land? – is a space underneath the natural ground. In hilly terrain, it is a space making use of slopes so as to be accessible at any level. On flat ground, it is simply a space below in a cityscape that may thereby be seen as 'deepened' and developed in all its dimensions.

We should thus reconsider the notion of natural ground, allow ourselves to rethink what a modern underground space may be, and above all rethink the relationship between underground and surface space – i.e. unify the understanding of space for the human user so that he may 'find himself around' in it (see [Illustration 2](#)).

2.1.3. Technique can now solve everything

Given that: 1. the differences between overground and underground space consist essentially of the fact that one is open and the other is solid, unseen, and only exists if it is dug out; 2. the similarities between overground and underground space hinge on the fact that the human being is the same when he is above-ground or

down below, with similar expectations, is it therefore possible to ensure equal quality and comfort whatever the environment? Today, we know that there are technical solutions to almost every problem – to provide quality air and light, acoustic and visual comfort in any space and even grow flowers and vegetables in a closed environment. It is possible to bring nature into the underground landscape so making the underground a pleasant space is definitely an option, depending of course on the willingness to do so and the balance with the many other parameters involved (economics, governance, management, knowledge, etc.), which will be reviewed below.

The transformation of an old underground Lowline streetcar depot in the high-density area of Manhattan is proof of that, as well as the Pasona O2 underground farm in the middle of the Tokyo business district, where a square mile of flowers, vegetable, fruit and even rice are grown for sale. In either case, sophisticated technologies are brought in, one to capture exterior solar/natural light, and the other to recreate it artificially (see [Illustration 3](#)).

If there are specific rules to follow when building underground, they have to do neither with the human user – who remains equally human, as we just mentioned – nor to the quality of the space which must respond to his needs, but to the awareness of intrinsic differences between subsurface and aerial spaces. Since there now are technical solutions to every problem, we should focus on questions concerning above all how the underground is approached and the place it will be given within the urban space. So, what are the main concepts any architect should consider when tackling underground construction?

2.2. General principles of underground architecture

Above all, we have to be aware of the fundamental difference between building above or below the ground surface.

Above ground, it is possible to see and go everywhere, through air. Conversely, below ground, unless you dig, you cannot penetrate the underground. Therefore, when working underground, we have to change our way of thinking.

2.2.1. Changing our way of thinking

Above ground, we can see everywhere, see the volumes constructed; below ground, we can see nothing. We have to change our conceptual models: it is interesting to note that when we are trying to build a 3D model of a town, we first draw the volumes and pay no attention to what is happening between these volumes; we think of the town as a group of buildings, with what remains between their volumes as public space. Underground, it is the opposite: the volumes are blind, they have to be opened or sliced to know what is happening, although dug out space is by essence public space.

2.2.2. Changing our way of seeing

2.2.2.1. *Create a void.* Above ground, we can move about freely in an open space, we can see a long way, while the opposite applies below ground: we cannot enter the underground unless it is dug out, excavated. Apart from natural caves, no underground space exists unless it was dug out; whereas above-ground, almost no interior space exists unless it was built.

2.2.2.2. *...or create an inhabited space?.* If space only exists underground if we dig it, and therefore from the time a human being enters it, this means that an underground space is an inhabited space.

When we dig, it seems as though we were producing a void, an empty space; this is a misconception: underground, any space is always, from the start, an inhabited space.

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