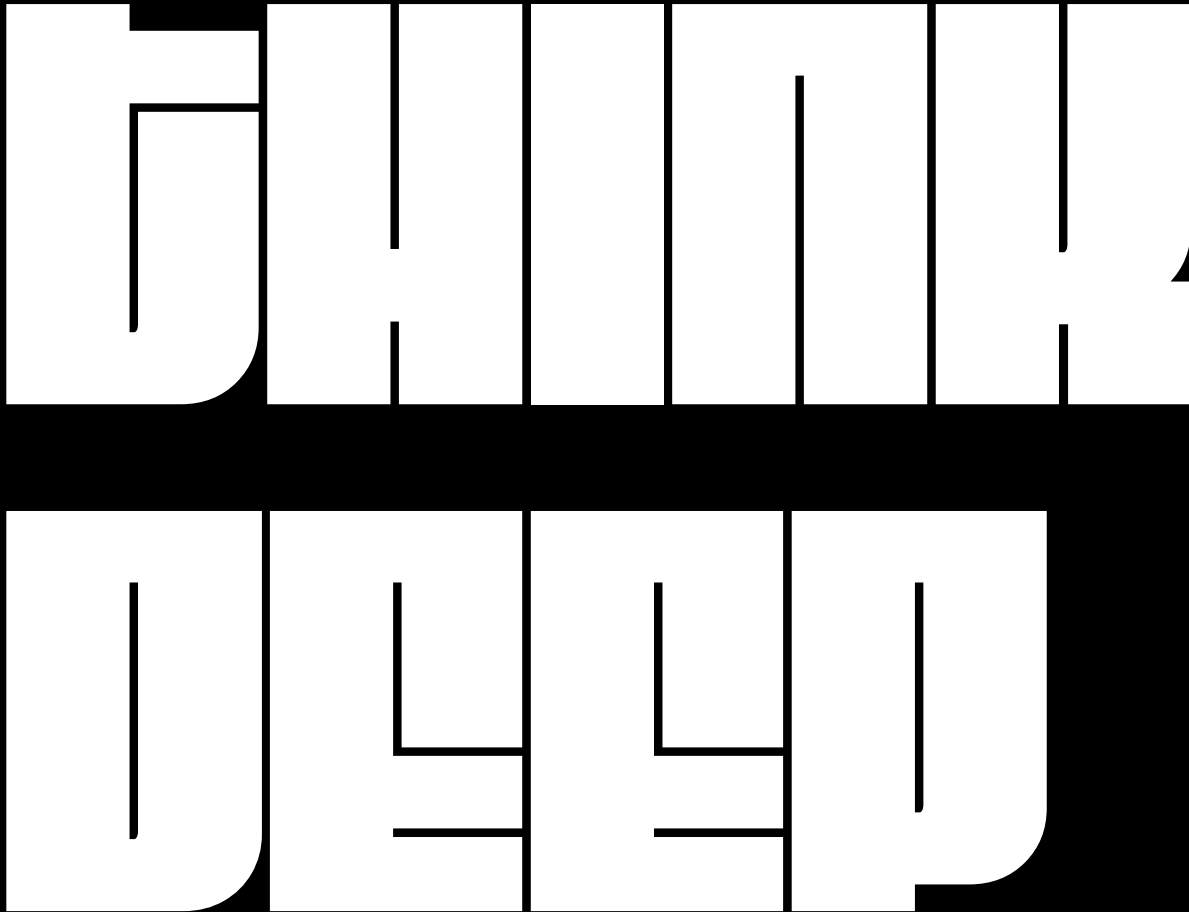


Research Plan

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City of the Future Graduation Studio 2023-2024



Idiosyncratic architecture for the underground, an extension of our urban fabric.

Keywords:

Underground, City, Urban fabric, Architectural language, Idiosyncratic, Future

Word count: 2664

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Turn the page upside down, does what you see in the drawing change?...
Food for thought...

Introduction, background and relevance

*Ghostly prints of red ochre dust;
Coins engraved with characters from Greek mythologies;
Sarcophagi cradling important ancestors;
Long tunnels created in order to access the valuable resources which would power the world;
Time capsules left behind by a kid seeking to communicate with future beings they can only imagine;
Water, waste, energy, information, cars, trains, rats, and people running through a labyrinth of tubes...*

*People gathering to talk about forbidden ideologies;
People dancing to non-conforming music;
People moving prohibited goods;
People sheltering from unbearable heat and deadly enemies;
People read about the devil and its demons hiding under their feet;
People watch movies about the scariness of the dark and unknown underground;
Gamers slaying dragons in caves and monsters deep inside earth's crust. Then store their loot in the safety of bunkers...*

What connects all these artifacts of our history and elements of our daily life is the underground. For humanity, the underground has always sheltered what is precious, yielded what is valuable, and allowed us to dispose of what is harmful¹.

TO FACILITATE OR TO DISPOSE

In contemporary history, the underground has for the most part been exploited to relieve the dense cities of above-ground pressure. One could say, it has been used by us to dispose of that which we consider undesirable above ground to facilitate further growth for our future.

It is fascinating how the underground, which stores so much knowledge and secrets about our history, is also widely considered the key to the future growth of our cities.

Cave_bureau wrote in their manifest:

*"Architecture started in a cave... in a way that was the start and bizarrely it could be the end. It could be the final chapter of architecture as we know it, back to the cave."*²

The message they try to convey is that architects should go back to the root of the issues and not assume the answer to a client's needs is always a building (above ground). There is quality in what the underground represents and what it can represent which should be embraced. Different cultures have their connotations, both positive and negative³, for some, it is home, and for some, it is where evil resides. Regretfully, in popular culture, it has mainly suffered from notoriety⁴.

¹Macfarlane, Underland.

²Caves as the Origin of Architecture.

³Admiraal and Cornaro, Underground Spaces Unveiled.

⁴Endicott, Johnston, and Lin, Underground Cities.

TO SHELTER OR TO ISOLATE

Experts agree that fundamentally rethinking the underground is the answer to many issues in cities associated with growth⁵. Such as increased land prices, congestion (of traffic and buildings), and neighbourhood deterioration⁶; developing better public transport networks, reducing noise, and leaving more green areas intact above ground⁷. We know that cities will continue to grow due to a lack of rural opportunities⁸. More than 60% of the world's population is projected to live in cities by 2030⁹

TO YIELD OR TO NEGLECT

What this graduation project will strive to do is to explore the vast resource all cities have, underground space. To understand how we can design, govern, plan, construct, and use underground space to contribute to the city we need and create the city we want. Further research into the intimate relationship between the under- and above-ground, their idiosyncrasies, and how they can complement each other is important to find out how they can provide what the city needs. The project aims to create an idiosyncratic architectural language which will allow people to “think deep” and reconsider the use of underground space and incorporate it into the city's fabric. To ultimately leave behind the culture of monodevelopment and defensive stance of spatial relief, and go towards a pre-emptive stance of spatial densification. Creating a new part of our cities which can help to meet modern norms and standards making use of the unique qualities the underground has to offer.

This raises the question:

Main research question: How can underground spaces be designed to respond to the cities' needs and create a new idiosyncratic addition to the city

⁵Endicott, Johnston, and Lin; Golany and Ojima, Geo-Space Urban Design; Admiraal and Cornaro, Underground Spaces Unveiled.

⁶Golany and Ojima, Geo-Space Urban Design.

⁷Admiraal and Cornaro, Underground Spaces Unveiled.

⁸Architecture and technology.

⁹United Nations, 'World Urbanization Prospects The 2018 Revision'.

Problem statement

In the past century certain cities, such as Montreal and Hong Kong, have developed underground spaces with successful implementation of public space, spaces of commerce and spaces of entertainment, while also facilitating pedestrian connectivity¹⁰. However, the general approach to underground space development remains flawed. It has often been exploited on a first-come-first-served basis solving momentary necessities without well-thought-out long-term commitment, legislation, and planning¹¹. It replaced certain above-ground (infra)structures which often improve the liveability of the supra-surface space, but at the cost of creating monofunctional and unattractive underground spaces¹². Consequently, contributing to its existing notoriety.

In a recent conversation with an engineer who works for the public transportation authority in a major US city, I brought up my thesis topic which elicited this response “Architecture? Underground? What is the point? Architecture stops underground level, the only thing we need underground is engineering. Leave that to us, engineers, haha, what are you even going to design underground?”.

... What is the cause of this perception within the professional world?

The development of underground spaces has largely been focused on function rather than its human occupants¹³. Golany wrote in 1996 that the development of underground space has two levels of issues: construction and usage¹⁴. The issue of construction can be met with modern technology, which has constantly been improving. High-performance materials and structures, artificial intelligence, information modelling and mapping, and improvements in tunnelling techniques are widely researched in civil engineering and reported in many publications¹⁵. The issue of “usage” however, encompasses socio-psychological attitudes that are much more difficult to address, causing this aspect to be neglected for a long time.

¹⁰Admiraal and Cornaro, Underground Spaces Unveiled.

¹¹Admiraal and Cornaro; Endicott, Johnston, and Lin, Underground Cities.

¹²Golany and Ojima, Geo-Space Urban Design.

¹³Endicott, Johnston, and Lin, Underground Cities.

¹⁴Golany and Ojima, Geo-Space Urban Design.

¹⁵Gong, Lei, and Shen, Advanced Underground Space Technology; Khoo and Ooi, ‘Geotechnical Challenges and Innovations in Urban Underground Construction – The Klang Valley Mass Rapid Transit Project’; Underground Engineering for Sustainable Urban Development; Cui et al., Design of Underground Structures; Debrock, Van Acker, and Admiraal, ‘Design Recommendations for Sustainable Urban Underground Spaces’.

Golany's definition of the "usage issue" is the socio-psychological attitudes that need to be addressed. However, reading his work and more recent literature it could be more nuanced, I define three different aspects:

- ♦ Governance covers all the legislative issues connected to the development of underground spaces;
- ♦ Urban development covers both the development of and investment into underground spaces as well as its effects on its context;
- ♦ Usage covers the socio-psychological human experience aspect.

Within these topics governance and urban development are being addressed in recent literature advocating for better approaches to underground spaces as a resource¹⁶. Usage is often mentioned but not often talked about more in-depth.

*However, as Endicott wrote in his book "Understanding how to make people feel comfortable in underground space is key to getting this largely untapped resource accepted as a natural extension of the city."*¹⁷

Underground structures shouldn't be just an insertion of buildings as we know them into the underground space they should be investigated for their qualities and have designs that reflect them and create new distinctive parts of the city with their unique atmospheres¹⁸. Recognising as well, its valuable position as four resources in one: space, water, energy, and geo-materials¹⁹.

¹⁶Admiraal and Cornaro, Underground Spaces Unveiled; Endicott, Johnston, and Lin, Underground Cities.

¹⁷Endicott, Johnston, and Lin, Underground Cities.

¹⁸Endicott, Johnston, and Lin.

¹⁹Admiraal and Cornaro, Underground Spaces Unveiled.

Four Main Topics

To better structure the problem, this research will be structured according to 4 topics which were presented as the main issues for further development of underground spaces, according to the main literature.

Underground and Theory

The use of underground space has undergone many changes after we left the caves. It has been used to store water, food, prisoners, unwanted people, the devil, to escape authority, to seek safety, and much more.

This topic will address vernacular design, historical precedents, and public biases towards the underground. It will look for past design customs which can be merged with modern theories to introduce innovative ideas which appeal to the general public and encourage the use of underground spaces.

Sub-research questions:

- ♦ *How has the underground been perceived by different people in history?*
- ♦ *What is the cause of negative biases towards the underground?*
- ♦ *Why is there such scepticism towards non-transport-oriented development of the underground?*
- ♦ *What are the reasons to not consider the development of underground spaces?*
- ♦ *What idiosyncrasies does the underground possess which make it distinctive and identifiable?*
- ♦ *What are the idiosyncrasies of the underground relating to the above ground?*
- ♦ *How is the underground presented in architectural drawings and how can these help reflect its qualities?*

Underground and City

New ideas are challenging what we can build underground and trying to incorporate more functions in the underground space. For successful use of the underground space, good city-level planning is needed. Foresight for long-term strategic visions and a clear redefinition of land ownership will be crucial to breaking this last frontier in urban planning and engineering²⁰. Most importantly a better understanding of what underground spaces can offer on the city scale is needed, but also what negative impacts bad design can have on the underground ecosystem.

This topic will focus on the functioning of public space within the three-dimensional network of the city and its systems; how it can provide for the city and its citizens; and how it can be governed and exploited responsibly.

²⁰Endicott, Johnston, and Lin, Underground Cities

Sub-research questions:

- ♦ *Who/What can benefit from further development of the underground?*
- ♦ *What types of underground spaces exist and how do they relate to their context?*
- ♦ *What types of empty underground spaces exist in cities which can be used in a better way?*
- ♦ *What types of soils are preferable for underground construction?*
- ♦ *Can they be reused as a construction material?*
- ♦ *What lasting impact does underground construction have on its surroundings?*
- ♦ *Where are suitable places to densify the underground?*
- ♦ *Which stakeholders need to be taken into consideration?*
- ♦ *Which needs of the city do underground spaces respond to and what other needs can underground spaces respond to in the future?*
- ♦ *What can the development of underground spaces provide for the systems of the city?*

Underground and Building

Designing new structures in underground spaces has been functionality and least-cost-driven²¹. Moving forward, much more holistic approaches are needed to extract the full value an underground structure could provide for its users, its surroundings, and the city as a whole. New ideas are necessary to create underground spaces that fulfil functional needs as well as create new spaces in the city which are enjoyable. Its idiosyncratic qualities should be embraced and should inform the choice of suitable functions²² as well as give space to “the element of contact between people” which is key to good urban spaces according to Mark Pimlott²³.

This part of the research will look more specifically into how the construction, materialisation, and building architecture can contribute to the city and the user.

Sub-research questions:

- ♦ *How can these idiosyncrasies be expressed architecturally?*
- ♦ *How can underground buildings benefit energetically?*
- ♦ *Which functions can make good use of the idiosyncrasies of the underground?*
- ♦ *How can the architecture respond to the underground as a resource of space, water, energy, and geo-materials?*
- ♦ *What is essential to make underground spaces liveable?*
- ♦ *What are the differences between designing underground spaces and above-ground spaces, architecturally speaking?*

²¹ Endicott, Johnston, and Lin.

²² Golany and Ojima, Geo-Space Urban Design.

²³ Pimlott, The Public Interior as Idea and Project.

Underground and Human(e)

When researching underground space and its relation to theory, city, and building an overarching theme should be encompassed in all, human. This is not only about how people can thrive in these new spaces, but also ethically speaking how one should approach the use of the underground. The ecological impact and lasting scars that will be made should be taken into account. Also, accessibility will be important, for whom will these spaces be designed, what will new underground spaces take away from ones who currently call these rare spaces home, and how can we avoid hierarchy which comes with verticality such as in above-ground towers? The research should always relate the topic to the underground and the human to explore what the underground can signify for the human experience. This will be an overarching theme which is kept in mind during the research of the other subtopics.

Sub-research questions:

- ♦ *Who can fall victim to the bad design of underground spaces?*
- ♦ *What socio-psychological benefits can the underground provide for its users?*
- ♦ *How can we avoid creating social hierarchy in underground spaces?*

[Ecology]

- ♦ *What ethical questions are there to consider when developing in the underground?*
- ♦ *What effect does the use of the underground have on underground ecology?*

Theoretical framework

It is important for clarity to define key terms used to describe excavated spaces. According to Loretta von der Tann, a possible definition for “underground” or “subsurface” structures is:

Structures and volumes can be considered “underground” when changing the structure or accessing the volume would require removal of or drilling into – natural or altered – ground²⁴

This is a very broad definition, thus in this research “underground” space will be used as a collective term to describe all relevant spaces according to the definition of von der Tann. For more specific descriptions the definitions from *Geo-Space Urban Design*²⁵ will be used:

- Earth-sheltered: mostly constructed above ground level, enveloped by a layer of earth.
- Semi-below ground: constructed partly below and partly above ground.
- Subsurface: shallow belowground structure with a short distance between its ceiling and the soil surface.
- Subterranean: spaces developed below ground at a reasonable depth – usually about three meters between the ceiling and the soil surface. Here an adequate amount of connections with the above ground can be expected for light, air, and access. This space is usually created by the “cut-and-use” method.
- Geo-space: spaces that are fully submerged deep within the earth at depths. (Most of the time 50 meters or more.)

Another way to categorise excavated spaces is to relate them to the way they relate to the ground of their context. Bjarne Mastenbroek and his office SeARCH defined six terms in their book *Dig It!*²⁶: bury, embed, absorb, spiral, carve, and mimic.

Golany’s definitions relate more to the depth of the structure within the underground and Mastenbroek’s relate more to the architectural relationship between the structure and the ground around it. In this research, Golany’s definition will be used when identifying and categorising case studies and research designs. Masternbroek’s will be used to better describe the architectural quality of certain underground structures.

²⁴Von Der Tann et al., ‘From Urban Underground Space (UUS) to Sustainable Underground Urbanism (SUU)’.

²⁵Golany and Ojima, *Geo-Space Urban Design*.

²⁶Mastenbroek, Mercredy, and Baan, *Dig It! Building Bound to the Ground*.

As mentioned in the introduction, this project also aims to identify idiosyncrasies of the underground and above-ground, to determine new ways of how they can complement each other.

Idiosyncrasies are “a distinctive or peculiar feature or characteristic of a place or thing.” – Oxford Languages²⁷.

Understanding these idiosyncrasies (which touch upon atmospheres, materials, and lighting...) will allow for the development of a distinct architectural language for the underground.

To define what architectural language is one has to look to the broader field of language. Language is a symbolic system²⁸, Seligmann argues that architecture also exists of different symbols and can be related to language in that way. Colin Cherry wrote that the whole of human communicative activity also includes the visual²⁹, and considering that visual language is defined so could other perceptive means be identified as part of the human communicative activity. If perception is language then phenomenology can identify a collection of architectural expressions which can be understood through different modes of perception and thus an architectural language can be defined. It is the collection of methods of architectural assets which convey a certain perception. To continue the metaphor, this research will consequently attempt to gather the necessary vocabulary to design the language of underground architecture.

²⁷<https://www.oed.com/>

²⁸Seligmann, 'Architecture and Language'.

²⁹Cherry, On Human Communication.

Methodology

To achieve the desired results with this research four main methods will be used to define and answer the problems stated in the problem statement categorised according to theory, city, building, and human(e).

Literature

The annotated bibliography is divided into main literature, literature about theory, city, and building. The main literature sources were used (with a few other supporting sources) to produce the research plan. Main literature sources will also further guide the research and design phase. Other literature is focused on more detailed information which will help to answer the sub-questions formulated in the problem statement.

Case studies and field visits

Case studies on vernacular examples, utopian concepts, and modern theories will be conducted. This will help to understand different approaches, uses, and cultural perceptions of underground spaces. Many can be found in the main literature sources. Others will be found during field trips to the Architecture Biennale in Venice, a visit to Milan, and if possible a visit to Helsinki.

Conversations with professionals

Conversations with professionals from different fields will be held to maximise input from different disciplines and gather different perspectives. This tool can also test the concepts designed in the fourth method, research by design, by discussing them with people who have different views on the matter.

Research by design

To ultimately work towards an architectural expression of the research an overarching method will be used: research by design. Where possible, the research will be translated into drawings or little designs forming a catalogue of information. Positioning them within a three-dimensional matrix. They will be categorised according to theory (literature), analysis (case studies), or new concept (provoked own ideas), then according to scale: landscape/infrastructure, city/urban, building/architecture element, and finally according to its relationship to the ground: earth-sheltered, semi-below ground, subsurface, subterranean, and geo-space (fig. X; appendix A).

Research diagram

The research diagram also shows how the topics, which will be researched using the aforementioned methods, lead to the definition of a design brief (Site, Function, Program, and Strategy), a concept, and ultimately a design (appendix B).

RESEARCH BY DESIGN
CATALOGUE

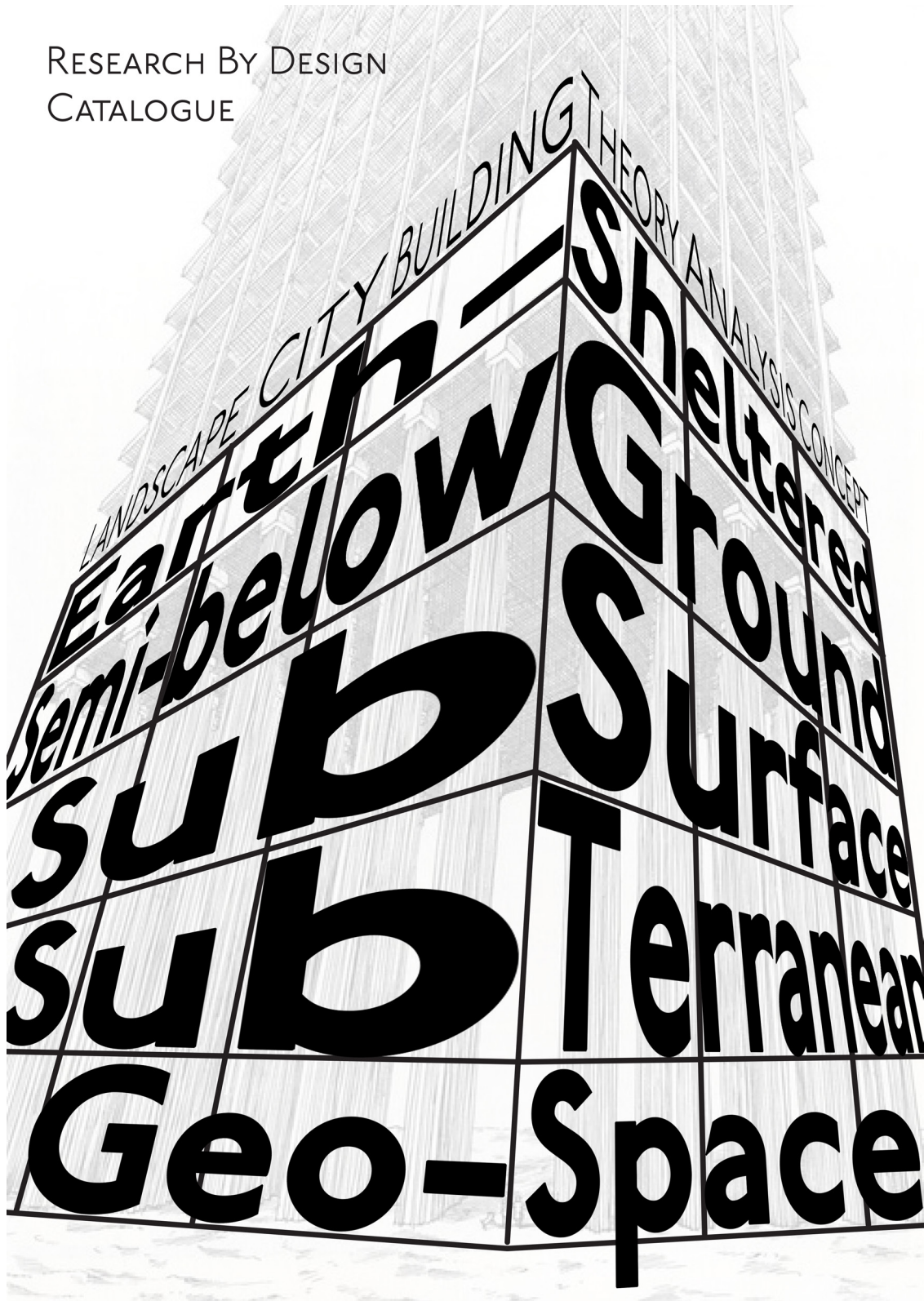


Figure 1: Matrix in which the research by design elements will be categorised.

Annotated Bibliography

Main literature

Admiraal, Han, and Antonia Cornaro. *Underground Spaces Unveiled: Planning and Creating the Cities of the Future*. London: ICE Publishing, 2018.

Han Admiraal and Antonia Cornaro are specialists in the world of underground spaces. This book talks about the issues that are associated with the sustainable development of urban underground space, the benefits, the possibilities, and some examples. Being published in 2018 it gives a good overview of recent developments and ideas about the underground.

Architecture and technology: future of cities. Madrid: Norman Foster Foundation, 2021.

This book is a collection of lectures and essays by experts who held talks at the Norman Foster Foundation about the future of cities. It is not specifically about the underground. However, as I am addressing future needs of cities this is a very interesting book about that and also gives insight into how different people from different disciplines and backgrounds think.

Endicott, John, Pamela Johnston, and Nancy F. Lin, eds. *Underground Cities: New Frontiers in Urban Living*. London: Lund Humphries, 2020.

This book is published by the company Aecom to review possibilities of the underground. It has many texts from experts about what the underground can provide for the city and a lot of examples of successful underground projects. It gives a good overview of what is done, and what is important to look into for the future of underground developments.

Golany, Gideon, and Toshio Ojima. *Geo-Space Urban Design*. New York, NY Chichester: Wiley, 1996.

For being published in 1996, *Geo-Space Urban Design* is quite ahead of its time. Golany had a strong fascination with the development of the underground and put all of his research into it in this book. It is extremely interesting and provides a strong basis to work on. By reading it critically and adding new things which help better reflect contemporary needs, norms, and values this book can help a lot. It will provide better understanding of the underground and what can be done with it.

Mastenbroek, Bjarne, Esther Mercredy, and Iwan Baan. *Dig It ! Building Bound to the Ground*. Köln [Paris]: Taschen, 2021.

This book is a thick collection of projects and examples of how buildings have related to the ground throughout history. Starting from the hunter-gatherers who lived in caves all the way will examples from the 21st century. This book gives comprehensive analysis of examples and different ways of interacting with the (under)ground.

Underground and Theory

Caves as the Origin of Architecture, 2023.

https://www.youtube.com/watch?v=uE8hjzIRIFg&ab_channel=LouisianaChannel.

Cave_bureau is a relatively young architecture firm, but they have a strong conviction which they state clearly in their manifesto. I find this manifesto very interesting, especially how they relate to the cave as where architecture started. It is interesting to explore their way of thinking and critical view on the built environment.

Lindner, Christoph, and Andrew Hussey, eds. *Paris-Amsterdam Underground: Essays on Cultural Resistance, Subversion, and Diversion*. Amsterdam University Press, 2013.

<https://doi.org/10.1515/9789048518203>.

Part of the underground has always been used as shelter and places for cultural resistance. This is definitely a part of history which helped shape the contemporary ideas surrounding the underground. This book will give an insight into that world, even if it is focused on two western European capitals.

Macaulay, David. *Underground*. Boston: Houghton Mifflin Company, 1979.

David Macaulay wrote this children's book about the underground. The most interesting part are the illustrations. They are a very interesting representation of how the underground can be represented with different drawings, drawn from different perspectives and using different techniques. This will be interesting to learn from in terms of ways of representation.

Macfarlane, Robert. *Underland: A Deep Time Journey*. First published as a Norton paperback. New York, N.Y: W.W. Norton & Company, 2020.

A critically acclaimed book which has won many prizes. It is a fictional story telling the non-fictional story of the Earth's underworlds as they exist in myth, literature, memory, and the land itself. This will be a very interesting book about the existing ideas about what the underground is, as well as what is factually in the underground. It may also help steer me towards a better understanding of what the underground can represent, positively.

Melo Zurita, Maria De Lourdes. 'Challenging *Sub Terra Nullius* : A Critical Underground Urbanism Project'. *Australian Geographer* 51, no. 3 (2 July 2020): 269–82.

<https://doi.org/10.1080/00049182.2020.1723829>.

A more theoretical and philosophical paper about how the development of the underground should be approached.

Nix, Chris, Siddy Holloway, David Bownes, and Sam Mullins. *Hidden London: Discovering the Forgotten Underground*. New Haven: Yale University Press, 2019.

A small book about the forgotten underground in London. It could be interesting to explore why it was forgotten, what is done with it now, and what potentials are. Also all the different kinds of functions it has served since its construction.

Pimlott, Mark. *The Public Interior as Idea and Project*. Heijningen: Jap Sam Books, 2016.

Pimlott, Mark, and Eleonoor Jap Sam. *Without and within: Essays on Territory and the Interior*. Rotterdam: Episode Publ, 2007.

Mark Pimlott writes (in both books) extremely interestingly about public spaces and public interiors. Which is also a major element of underground spaces. These books can help me inform on ways to look at public spaces and public interiors (thus underground spaces) and also help guide me in my design of them later. [He also writes about the underground space in Montreal in *The Public Interior as Idea and Project* which is interesting for the beginning of my research]

Soules, Matthew. *Icebergs, Zombies, and the Ultra-Thin: Architecture and Capitalism in the Twenty-First Century*. First edition. New York: Princeton Architectural Press, 2021.

This book talks about the capitalistic forces which have driven a lot of architecture. I have always been interested in the effect of it on how the current world is constructed and viewed and maybe it can also help improve my proposals for the underground or better understand why it isn't yet being developed as much as the above ground. The title also mentions icebergs, they have hummocks and bummocks, as I see it these skyscrapers are the hummocks and the underground is the unexplored bummock. I am interested in why he mentions icebergs in his title.

Stalter-Pace, Sunny. *Underground Movements: Modern Culture on the New York City Subway*. Science, Technology, Culture. Amherst: Univ. of Massachusetts Press, 2013.

Similarly to the book about Paris-Amsterdam underground, this book will help get a better understanding of the underground culture and how underground has influenced culture in such big cities such as New York.

Underground and City

Bai, Yun. *Underground Engineering: Planning, Design, Construction and Operation of the Underground Space*. London [England] ; San Diego, CA: Academic Press, 2019.

Recent scientific papers about the planning, design, construction, and operation of underground spaces help to keep up with current technology and also provide valuable comparisons between these publications and the books in the main literature which also cover this topic.

Banham, Reyner, and Todd Gannon. *Megastructure: Urban Futures of the Recent Past*. Facsimile edition. New York, New York: The Monacelli Press, 2020.

A classic about many visionary and utopian ideas about the future cities originally published in 1976. What was considered crazy ideas back then might not be as crazy today as we see with projects such as The Line. So it is interesting to revisit these provocative ideas and gain another perspective (of the recent past) on cities.

Broekmans, Tess, and Catja Edens. *The Spontaneous City*. Amsterdam: BIS Publishers, 2010.

Many literature (such as the books from Mark Pimlott) suggest that successful cities and public spaces stem from human interaction and spontaneousness. This theory from Urbahn on how to approach urban design is also interesting and could be something to inform later research and design.

Broere, Wout. 'Urban Underground Space: Solving the Problems of Today's Cities'. *Tunnelling and Underground Space Technology* 55 (May 2016): 245–48. <https://doi.org/10.1016/j.tust.2015.11.012>.

A paper with a short summary of what underground spaces can provide to help solve the problems of today's cities. Here two things are valuable: the problems of today's cities, and how underground space can contribute to solving them.

Chen, Renpeng, Gang Zheng, and Changyu Ou, eds. *Proceedings of the 2nd International Symposium on Asia Urban GeoEngineering*. Springer Series in Geomechanics and Geoengineering. Singapore: Springer Singapore, 2018. <https://doi.org/10.1007/978-981-10-6632-0>.

Recent publication on geoengineering, this approaches these underground spaces form a geoengineering point of view. Which is especially important when taking ecology of the underground into account.

Doyle, Michael R. 'Mapping Urban Underground Potential in Dakar, Senegal: From the Analytic Hierarchy Process to Self-Organizing Maps'. *Underground Space* 5, no. 3 (September 2020): 267–80. <https://doi.org/10.1016/j.undsp.2019.04.004>.

This could be an interesting read about the mapping of underground potential. Mainly to learn what methods were used, what prerequisites, in order to possibly apply a similar approach in search of a site for the design.

Frampton, Adam, Clara Wong, and Jonathan Solomon. *Cities without Ground: A Hong Kong Guidebook*. Rafael, Calif.: Oro editions, 2012.

The underground is not the only things in cities, it needs to be connected with the above ground. This book talks about this verticality in Hong Kong and also shows interesting ways of representation, by “deleting” the ground.

Khoo, Chee-Min, and Teik-Aun Ooi. ‘Geotechnical Challenges and Innovations in Urban Underground Construction – The Klang Valley Mass Rapid Transit Project’.

Geomechanics and Tunnelling 16, no. 3 (June 2023): 243–62.

<https://doi.org/10.1002/geot.202300007>.

Geotechnical challenges is something I really don’t know a lot about but definitely something I would like to take into consideration. As it is mentioned by Han Admiraal that even though the geological cycles of the Earth are on a different timeline than what we can plan for we are starting to feel the effects of mankind on these cycles.

Peng, Fang-Le, Yong-Kang Qiao, Soheil Sabri, Behnam Atazadeh, and Abbas Rajabifard. ‘A Collaborative Approach for Urban Underground Space Development toward Sustainable Development Goals: Critical Dimensions and Future Directions’. *Frontiers of Structural and Civil Engineering* 15, no. 1 (February 2021): 20–45. <https://doi.org/10.1007/s11709-021-0716-x>.

Recent paper with information about the current approaches of the development of urban underground space.

Qiao, Yong-Kang, Fang-Le Peng, Xiao-Lei Wu, and Yong-Peng Luan. ‘Visualization and Spatial Analysis of Socio-Environmental Externalities of Urban Underground Space Use: Part 1 Positive Externalities’. *Tunnelling and Underground Space Technology* 121 (March 2022): 104325. <https://doi.org/10.1016/j.tust.2021.104325>.

———. ‘Visualization and Spatial Analysis of Socio-Environmental Externalities of Urban Underground Space Use: Part 2 Negative Externalities’. *Tunnelling and Underground Space Technology* 121 (March 2022): 104326. <https://doi.org/10.1016/j.tust.2021.104326>.

Recent paper with information about the socio-environmental externalities of urban underground space. This can inform certain socio-psychological topics that need to be researched.

Shannon, Kelly, and Marcel Smets. *The Landscape of Contemporary Infrastructure*. Rotterdam: nai010 publishers, 2016.

Interesting urbanists on the landscape of infrastructure. The underground plays a big role in the infrastructure of cities (and countries, or even across countries) so understanding of that topic is also important.

Underground Engineering for Sustainable Urban Development. Washington, D.C.: National Academies Press, 2013. <https://doi.org/10.17226/14670>.

Information about more sustainable approaches to development of the underground.

Von Der Tann, Loretta, Stefan Ritter, Sarah Hale, Jenny Langford, and Sean Salazar. ‘From Urban Underground Space (UUS) to Sustainable Underground Urbanism (SUU):

Shifting the Focus in Urban Underground Scholarship'. *Land Use Policy* 109 (October 2021): 105650. <https://doi.org/10.1016/j.landusepol.2021.105650>.

First of all, she attempts to define underground spaces of subterranean spaces. Secondly, also suggests a new approach to underground urbanism.

Zhang, Yangbin, Zhiqiang Xie, Fengshan Jiang, Tong Xu, Shouquan Yang, Siqiao Yin, Fei Zhao, et al. 'Evaluating the Socioeconomic Value of Urban Underground Space in Kunming, China, Using the Entropy Method and Exponential Smoothing Prediction'. *Journal of Urban Planning and Development* 149, no. 2 (June 2023): 05023001. <https://doi.org/10.1061/JUPDDM.UPENG-4123>.

Socioeconomic value of new urban spaces is becoming more and more important as investment in these new spaces and infrastructure aren't just cost-driven anymore but more value-drive which now often includes social values.

Underground and Building

Cui, Zhen-Dong, Zhong-Liang Zhang, Li Yuan, Zhi-Xiang Zhan, and Wan-Kai Zhang. *Design of Underground Structures*. Singapore: Springer Singapore, 2020. <https://doi.org/10.1007/978-981-13-7732-7>.

Some information about the engineering point of view to the design of underground structures.

Debrock, Shana, Maarten Van Acker, and Han Admiraal. 'Design Recommendations for Sustainable Urban Underground Spaces'. *Tunnelling and Underground Space Technology* 140 (October 2023): 105332. <https://doi.org/10.1016/j.tust.2023.105332>.

Some suggestions of important design elements of underground space which should definitely be utilized and taken into account.

Gong, Chenjie, Mingfeng Lei, and Xianda Shen, eds. *Advanced Underground Space Technology*. MDPI, 2022. <https://doi.org/10.3390/books978-3-0365-5534-8>.

This paper talks about recent innovations in the technology used to build underground spaces.

Lawrence, David. *Underground Architecture*. Harrow, Middlesex: Capital Transport, 1994.

Interesting to see what was understood and considered underground architecture in 1994, what role architecture (could have) played in the development of underground spaces.

Mukhtar, A., M.Z. Yusoff, and K.C. Ng. 'The Potential Influence of Building Optimization and Passive Design Strategies on Natural Ventilation Systems in Underground Buildings: The State of the Art'. *Tunnelling and Underground Space Technology* 92 (October 2019): 103065. <https://doi.org/10.1016/j.tust.2019.103065>.

Some more technical information to inform design choices in a later stage.

Oćłoń, Paweł. *Renewable Energy Utilization Using Underground Energy Systems*. Vol. 84. Lecture Notes in Energy. Cham: Springer International Publishing, 2021. <https://doi.org/10.1007/978-3-030-75228-6>.

There is a lot of talk about the underground as a source of energy, this will definitely be explored in both the research and the design.

Supporting Literature Research Plan

Cherry, Colin. *On Human Communication: A Review, a Survey, and a Criticism*. 3. ed. Studies in Communication. Cambridge, Mass.: MIT Pr, 1982.

Seligmann, Klaus. 'Architecture and Language: Notes on a Metaphor'. *Journal of Architectural Education* 30, no. 4 (April 1977): 23–27. <https://doi.org/10.1080/10464883.1977.10758122>.

United Nations. 'World Urbanization Prospects The 2018 Revision'. World Urbanization Prospects. New York, N.Y, 2019.

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