Why Go Underground?
For hundreds of thousands of years, our natural domain has been mainly a two-dimensional space.
Nature, and not mankind, is at the origin of the first underground works.
Cave dwellings were an important landmark in the use of underground space by mankind (France)
Since the dawn of human endeavor, numerous reasons have encouraged mankind to use and develop underground space.
The Malpas Tunnel on the Canal du Midi
(France - late 17th Century)
The Saint Gothard Tunnel
(Switzerland - Late 19th Century)
Powerhouse of the Serra da Mesa hydroelectric power plant (Brazil)
Fundamental characteristics of underground space

• Underground medium is a space that can provide the setting for activities or infrastructures that are difficult, impossible, environmentally undesirable or less profitable to install above ground.

• Underground space offers a natural protection to whatever is placed underground.

• The containment created by underground structures protects the surface environment from the risks / disturbances inherent in certain types of activities.

• Underground space is opaque: an underground structure is only visible at the point(s) where it connects to the surface.
Reasons for going underground

• Land use and location reasons
• Isolation considerations
• Environmental protection
• Topographic reasons
• Social benefits
Reasons for going underground

(1) Land use and location reasons
Blaak Station
(Rotterdam - The Netherlands)
Underground expansion of the Swedish Royal Library (Stockholm - Sweden)
Le Grand Louvre (Paris - France)
Tokyo Subway - Iidabashi Station
(Tokyo - Japan)
La Defense Urban Hub
(Paris - France)
Reasons for going underground

(2) Isolation considerations
The Santa Claus Village

Unique Christmas theme park on the Arctic Circle in Finnish Lapland
Underground hospital in a potash salt mine for allergy treatment
(Ural - Russia)
Underground swimming pool (Finland)
Gjovik Olympic Mountain Hall
(Norway)
Above-ground structures are more sensitive to earthquake than underground ones

Kobe Earthquake (Japan - 1995)

Severe damage to the Kobe City Hall

No damage to the underground shopping mall located below
Underground crude oil storage facility
Kuji Plant (Japan)
Underground storage facilities
Kansas City (USA)
Underground Church in Rock
(Helsinki, Finland)
University of Minnesota (USA)
Yucca Mountain Site characterization project
(Nevada - USA)
Reasons for going underground

(3) Environmental protection
Car park at the square Estienne d’Orves in Marseilles (France)
Situation «before» and «after» the construction of the underground car park
Thanks to the use of subsurface, a car park could be located in the very proximity of the Sydney Opera House (Australia)
Variety of the underground infrastructure in a city
A motorway tunnel forming a green bridge, providing a free range for people, animals, and even vegetation (Finland)
The Green Heart Tunnel
(The Netherlands)
Reasons for going underground

(4) Topographic reasons
The Gothard Base Tunnel
(Switzerland)
Mont Russelin Tunnel
on National Highway A16
(Switzerland)
High speed railway tunnel
(Germany)
Trans Tokyo Bay Highway
(Japan)
The Noord Tunnel
Amsterdam
(The Netherlands)
Expanded use of underground space
The new Antwerp Central Station on the Paris-Amsterdam high speed rail link (Antwerpen - Belgium)
Reasons for going underground

(5) Social benefits
"Tunnels play a vital environmental role by conveying clean water to and by conveying wastewater out from urban areas."

The Lesotho Highlands Water Project
Waste water treatment plant in Helsinki (Finland)
« Tunnels provide safe, environmentally sound, fast, and unobtrusive urban mass transit systems »

Paris Metro
Line 14 - «Meteor»
(France)
« City traffic tunnels clear vehicles from surface streets, traffic noise is reduced, air becomes less polluted and the surface street areas may partially be used for other purposes »

The Central Artery in Boston (USA)
The A86 West Underground Link-up
(Paris Region - France)
"Underground car parks in city centres leave room for recreation areas and playground above ground."

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Underground car park below a school yard
(Stockholm - Sweden)
The Paris Town Hall underground car park
(France)
“Multipurpose utility tunnels are less vulnerable to external conditions than surface installations and will cause only insignificant disturbance above ground when installed equipments are repaired or maintained”

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Utilidor
(Paris - France)
Assessment of the underground structures

(1) Taking into account life-cycle costs
Prices for mining & lining ~20' Dia. Tunnels

Tunnel Cost per Lineal Foot (Converted to 1995 dollars)

Year

Earth
Rock
Mixed or varying
Regression
Cost comparison between hydrocarbon storage in rock caverns and in steel tanks
Assessment of the underground structures

(2) Taking into the indirect benefits of the underground structures
Risk analysis in underground works
Three-Centered Station Shield
Metro of Tokyo (Japan)
### ITA-AITES Working Groups

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