Enlightened Underground
Amsterdam, 28.01.2008

Underground Space Challenges in Urban Development

Worldwide Use of Underground Space - Solutions to Urban Challenges

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Use of Underground Space

... since the first days of mankind ...

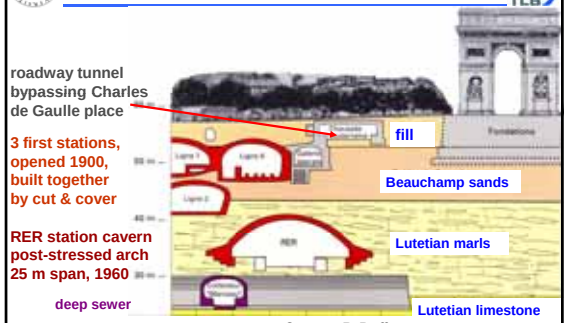
Derinkuyu

Underground city, Cappadocia, Turkey

- carved into the tuff
- first built by the Phrygians in the 8th-7th centuries B.C
- could be closed from inside with large stone doors
- storerooms and wells that made long stays possible
- air shafts which are up to 30m deep
- possible shelter for thousands of persons

Source: bldgblog

Charles de Gaulle Metro Station



Source: P. Duffaut

ITA WG 20 "Urban Problems - Underground Solutions" in cooperation with ACUUS

- overview of the typical challenges of urban city planning
- sustainable solutions offered by underground space use
- Report in preparation:
  - urban problems,
  - underground solutions,
  - key decision factors
  - unique case histories

Worldwide Use of Underground Space Solutions to Urban Challenges

- **Typical Urban Problems**
- Typical Underground Solutions
- Key Factors in the Decision Making Process

Growth of Urban Populations

Mega-Cities (> 5 Million)

- 1940 : 2 (New York, London)
- 1990 : 30
- 2005 : 62

Very large cities (> 1 Million)

- 1940 : 2 (New York, London)
- 2005 : 437

Typical Urban Problems

- Growth
- Urban (Re-)development / Architectural quality
- Service quality
- Safety and security
- Traffic capacities / Connecting traffic modes
- Travel time
- Noise
- Pollution
- Flooding
- Synergy effects

Traffic Capacities / Urban Development

Düsseldorf
Rhine
Embankment
Road
1988

Environment: Noise and Pollution

Beijing
(thewe.cc)

Moscow
(inmoskau.de)

Santiago de Chile
(britannica.com)

Flooding

Kuala Lumpur

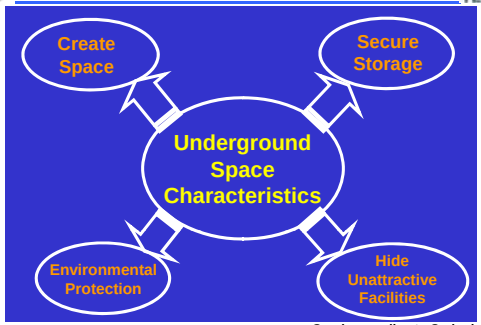
Cologne

Rainwater overload in sewage

Worldwide Use of Underground Space
Solutions to Urban Challenges

- Typical Urban Problems
- **Typical Underground Solutions**
- Key Factors in the Decision Making Process

Key Characteristics of Underground Space



Graph according to Godard

There are lots of good reasons for using underground space!

... and very few not so good ones:

"Collapse" of El Salvador bankrobbery tunnel, Tunnels&Tunnelling, 2/06

Typical Underground Solutions

- Subway systems, underground light rail, underground rail
- Road tunnels
- Pedestrian tunnels
- Underground parking
- Underground public service facilities
- Underground cultural facilities
- Energy transport or energy production
- Underground production and storage
- Utility tunnels
- Storm water relief systems

Underground Parking

« Estienne d 'Orves » Square Marseilles

BEFORE
(Parking facility)

AFTERWARDS
(Parking facility)

Riverfront Road Tunnel: Rheinufertunnel (Riverfront Tunnel) Düsseldorf

Riverfront road in the 70s, separating the historic center from the river

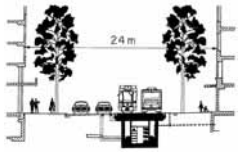
Traffic on the riverfront road

Riverfront Road Tunnel: Rheinufertunnel (Riverfront Tunnel) Düsseldorf

Rhine Riverfront Today

Utility Tunnels

New York, 1912



Zürich

Zürich, Löwenstr.

Utility Network for Climatisation: CLIMESPACE, Paris

Worldwide Use of Underground Space Solutions to Urban Challenges

- Typical Urban Problems
- Typical Underground Solutions
- **Key Factors in the Decision Making Process**

Key Factors in the Decision Making Process

- Quality of life
- Cultural heritage
- Property Values
- Prognosis of user demands
- Economical / financial funding models
  - Direct (initial) and indirect costs
  - Life cycle costs: initial price tag shock is lessened by lifecycle cost discussion
- Feasibility and impact of key construction technologies
- Environmental impacts
- Safety and security issues
- Unique innovation aspects
- Communication!

Development of Property Values - Indicators for Quality of Life

Source: Tunnels&Tunnelling

Impact of Excavation Methods

Impact of Excavation Methods

- existing buildings
- existing utility lines
- traffic to be maintained
- property rights
- local residents and businesses

Ecological Impact

Disadvantages of current methods for Environmental Impact Assessment (EIA):

→ Singular consideration of effects of completed constructions

→ Time and cost consuming accomplishment

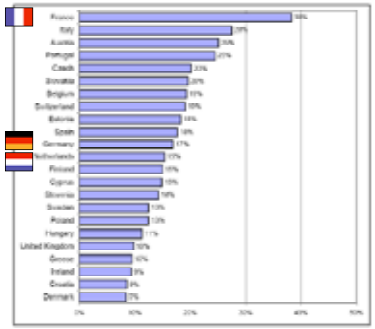
→ Missing decision criterions

→ No regulations how effects on the environment should be assessed or weighted

→ An overview describing the ecological aspects of different construction methods is not available

- This deficits lead to a development of an evaluation model for ecological aspects!

SARTRE3 (2004)
Social Attitudes to Road Traffic Risk in Europe



SARTRE interrogation:

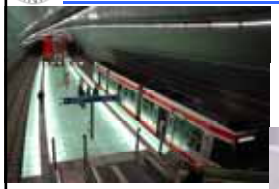
Very or fairly frightended when driving through a long tunnel?

Aesthetics

Jubilee Line: Canary Wharf
Foster and Partners

Source: Below Ground Level

Security and Aesthetics



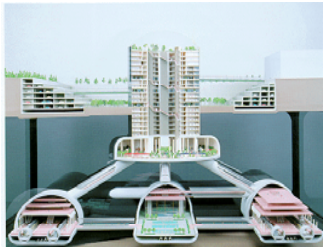
Subway Bochum
Station Lohring

Subway Düsseldorf
Station Oberbilk

Security

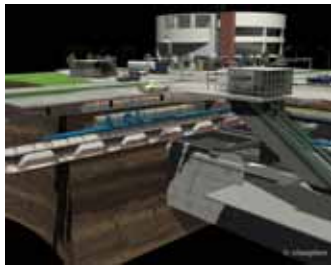
Daegu Subway Arson, 2003

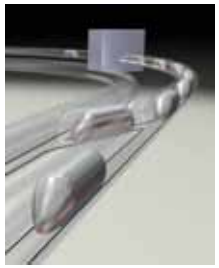
Future Visions?



Geotrapolis, Japan
Realisation by 2020?

Future Visions!





CargoCap: Autonomous Capsule Transport for Freight Transport

Underground Solutions = High Profile Solutions

Towards New Challenges in the Underground Space