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# Tunnelling and Underground Space Technology

journal homepage: [www.elsevier.com/locate/tust](http://www.elsevier.com/locate/tust)

## The significance of the underground experience: Selection of reference design cases from the underground public transport stations and interchanges of the European Union

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### ARTICLE INFO

#### Article history:

Received 12 August 2015

Received in revised form 11 December 2015

Accepted 24 December 2015

Available online xxx

#### Keywords:

Urban underground space

Public transport interchange

### ABSTRACT

**Background:** Recent research into the way public transport users appreciate stations and interchanges has highlighted several key aspects. Importantly, the optimization of these facilities should not simply aim to resolve dissatisfiers, but should also focus on addressing satisfiers, through the incorporation of factors such as comfort and experience. ‘Soft requirements,’ which have emerged in architecture and urban design, need to crossover to the urban underground infrastructure (as an element of urban underground space) in order to meet the expectations of public transport users.

**Method:** This study applies an innovative methodology in the analysis of good practice in urban underground space design, a method more commonly found in cultural studies. Three dimensions in the appreciation of a creative design are considered: views held by the general public; views held by peers (other artists or designers); and views expressed by critics. Using this framework, the article discusses prominent showcases of European underground public transport stations and interchanges, in order to identify design principles that determine a positive user experience of an urban underground space.

**Results:** A comprehensive overview of good practice with regard to urban underground station design was produced, using reference design cases. The cases included are: Canary Wharf Underground Station; the Georg-Brauchle-Ring Station; Souterrain Tram Tunnel; Triangeln Railway Station; Toledo Metro Station; Fövám Tér Station and Szent Gellért Tér Station (Twin Stations); Chatelet-Les Halles RER Hub; Canary Wharf CrossRail Station; and Birmingham New Street Station. Analysis of these reference design cases (and the good practices involved) allows for the description of ‘satisfying’ design solutions.

**Conclusion:** A robust analysis of a well-designed urban underground space can be made based on the opinions of users, peers and critics, through the use of social media, via recognition in prizes and awards and through indexed architectural periodicals. The design principles constituting good practice in underground space design identified in this study are: canopy; open station box; underground morphology and textures; architectural light; intervisibility; art; volume; and proximity.

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## 1. Introduction

Underground space is increasingly intertwined with the city above. If an urban underground space is well designed it can be intricately linked to the rest of a built environment. As such, the strategic use of underground space has the potential to improve quality of life in urban areas, through increases in density, proximity and livability. Bobylev (2009) was one of the first researchers to

address this field with a specific name: *urban underground space*, abbreviated to *UUS*.

In the context of urban underground space, we investigate innovative design principles in a select group of showcases, public transport stations and interchanges situated in the European Union. Public transport stations and interchanges (also referred to as mass transit stations and hubs) are part of the so-called *Urban Underground Infrastructure* (UII), a term also coined by Bobylev (2006).

Users of underground public transport facilities typically have high quality standards, which the overall design of underground stations and interchanges is not always able to meet. The logistics

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involved in high speed trains, heavy rail or metro systems, combined with demanding civil engineering requirements, typically makes a strong impact on the overall design of a station. As a result, it becomes a challenge to address specific aspects that contribute to making people truly appreciate the experience of being underground. These are qualitative requirements such as orientation, visibility, wayfinding (van der Hoeven and van Nes, 2014), ambiance and attractiveness (Durmisevic and Sariyildiz, 2001), and comfort and experience (van Hagen and Heiligers, 2011).

“...What for engineers would have been problems to be solved in the most straightforward way became opportunities for architectural creation”.

[Worsley, 1999]

Designers are often better trained to deal with qualitative matters. Besner (2014) observed that “the design of the stations became increasingly the task of architects.”

The aim of this article is to address the importance of *experience* in the design of an urban underground space. As such, the article reports the outcome of a joint research project in 2014 by the Delft University of Technology and Gdansk University of Technology, entitled *Innovative Public Underground Buildings of the Contemporary City*. The project involved staff exchange, discussions, site-visits of key showcases, and engaging in the annual Dutch Centre for Underground Construction and Underground Space (COB) event.

In addition, this article addresses the findings and outcomes of the NODES project, funded by the Seventh Framework Programme (FP7) of the European Union over the period 2012–2015.

This article investigates two main research questions:

1. How can we select, identify and analyse good practices in urban underground space design in a way that is more robust than most current case study evaluations?
2. What are the design principles in underground public transport stations and interchanges that contribute to an overall positive experience of the urban underground space?

The article comprises the following paragraphs: (1) *Introduction* includes the primary objective of the research and two questions central to the research; (2) *Background* addresses the research on dissatisfiers and the need to look into satisfiers; (3) *Method* outlines the steps in a novel method for analysing public, peer and critic appreciation of design concepts for underground stations; (4) *Results* include systematic descriptions on the underground reference design cases stations that were analysed; (5) *Design concepts* describe solutions that the reference design cases have in common and receive the most positive feedback from peers, the public and critics; (6) *Conclusions* describe the answers to the two research questions that are central to the research, as well as significance, shortcomings and future research directions.

## 2. Background

Over the past decades, research into underground space utilisation has been conducted by centres and associations all over the world, including meta-organisations such as the International Tunnelling and Underground Space Association (ITA) and the Associated Research Centers for the Urban Underground Space (ACUUS). The organizational reach of ‘traditional’ underground organisations increases through new partnerships with organisations such as the International Society of City and Regional Planners (ISOCARP). The rationale for the research and increased collaboration is typically explained on the basis of one or more societal benefits that the use of underground space brings. Exam-

ples of such benefits are described in the ITA Report n° 011 (*Report on Underground Solutions for Urban Problems*) and the joint publication of ITA and ISOCARP (*Think Deep: Planning, Development and Use of Underground Space in Cities*). A rapidly urbanising world provides a pretext in which there is a need to use space more efficiently. In this context, key benefits and drawbacks of underground space are formulated. Although underground space seems to be good to society at large, most research is uncertain if individuals actually appreciate being underground (Durmisevic, 2002; Admiraal & Narang Suri, 2015). The relationship between people and the underground seems to be ambiguous at this point in time.

Carmody and Sterling (1987) have highlighted the potential negative experiences that underground facilities bestow upon their users. These experiences derive largely from two factors: psychological (culturally learned images of the underground, negative connotations of these and previous experiences), and attitudinal (a lack of natural light, lack of fresh air, indoor air pollution, high humidity, excessive noise or the opposite, a lack of noise). Carmody and Sterling (1993) went on to deliver careful design guidelines that alleviate the negative effects they found in order to provide spatial quality. These guidelines revolve around ‘proper’ designed building elements such as entrances, the building layout, and the interior space, with a focus on providing natural light and exterior views.

Most of the research into urban underground space has been focused on optimising so-called dissatisfiers, such as the lack of daylight or difficulties with orientation. Focusing on dissatisfiers alone carries the risk that urban underground space is bound to stay one step behind the aboveground urban space, both in terms of comfort and experience. A different approach may be required, as highlighted in an interview with Sir Norman Foster: “... when carrying out research into underground structures for this project, I discovered that many designers do everything they can to make the space look as if it’s above ground. I object to that, because the underground can create an extraordinary atmosphere of almost religious intensity” (von Meijenfeldt et al., 2003).

The European Union has highlighted the need for developing new approaches towards station design. It issued a call in its 7th Framework Programme (FP7) asking for innovative approaches relating to the design of new or upgraded transport interchanges (see Fig. 1). A consortium led by the International Association of Public Transport (UITP) responded to successfully obtain a project in this area: NODES. The objective of the NODES project was to deliver a toolbox to support the design and operation of new and upgraded urban transport interchanges (van der Hoeven et al., 2014). Amongst the numerous research projects, policy documents, and good practices that/which this project analysed, is the research of Mark van Hagen and the good practice identified in the *Station Experience Monitor* by the Dutch Railways. Mark van Hagen, senior project leader for strategic research of the Dutch Railways, divides the needs of public transport users in two groups, dissatisfiers and satisfiers, with safety and reliability as prerequisite basic conditions (see Fig. 2). Speed and ease (or more specifically their lack) are dissatisfiers, whilst comfort and experience are satisfiers. Experience is regarded as the strongest among the two satisfiers. Based on this methodology, the Dutch Railways started to measure the experiences of public transport users by means of the so-called *Station Experience Monitor*. Since 2011, the Dutch Railways have obtained structured data on the experience of passengers at 350 train stations in order to improve the services they offer.

“The questions put to the customer during the field studies exceeded process-related questions on the state of repair, safety and cleanliness, the conventional idea in the railway sector often being that the atmosphere will probably not be highly

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