SPACE INDICATING ROUTES

An investigation into how spatial design can guide people to find routes at a multi-modal transfer station in Berlin.

complex projects

by Xiaotian Liu (5568005)

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CONTENTS

INTRODUCTION

01

1.1 Thesis Topic

Train stations and the evolution of modern metropolitans have always gone hand in hand. Since the earliest emergence of horse-drawn stations, urban mobility has been a constant topic of development, a huge design issue that requires the collaborative participation of architects, planners, traffic engineers, etc. From an architectural point of view, as the physical space carrier of the most popular means of transportation in the last century, the train station, its form, function, scale, and technology have always reflected the latest trends in social transformation. Nearly forty years ago, Meeks' research listed four stages of railway station development from the 19th to the 20th century: classical, baroque, eclecticism, and modern.[1] The various stages are also clearly indicated as being characterized by a shift from closed, linear to transparent, and interpenetrating.[2] This transformation also reflects the social and technological changes that have occurred over the past 100 years, including innovations in building materials and transportation, the transformation of people's lifestyles through digital culture, etc.

Looking at the train station today, it is still constantly developing and evolving. Urbanization and the energy crisis urgently require architects to come up with a more complex and integrated project. The current urban transportation networks are made of different graded modes, from long-distance or regional trains to metros, trams, and buses, with collective or individual vehicles, with regulated or unregulated and free systems, and now with emerging micro-mobilities and possible new autonomous vehicles.[3] Nowadays train station has to deal with multiple modes and different scales of transportation, which is the definition of a multi-modal transfer station. At the same time, multi-modal transport terminals are being practiced among EU countries. In France, the goal of more multi-modal mobility is being written into law, alongside other goals (e.g., "a more secure, more connected, more sustainable mobility").[4] The Netherlands has also made major improvements to main train hubs such as Utrecht and Arnhem stations. However, as Kaminagi pointed out, efficient interchanges in inter-modal stations are still limited or difficult especially if they are large nodes or if they include bus stations.[5] The introduction of multi-modal stations requires passengers to proactively seek their way and then enter various modes of transportation. In this case, the way-finding system of the multi-modal terminal is particularly relevant.

Kevin Lynch pointed out early on that urban space is perceptible and that five elements of space (nodes, paths, districts, landmarks, and edges) have a significant impact on perception.[6] Similarly, architectural spaces are also legible, the legibility of a building is the degree to which a building facilitates the ability of users to find their way within it.[7] Therefore, the design of the different hierarchical spaces in the multi-modal stations is crucial to the user's perception and experience. Spatial legibility and recognition become the key to way-finding systems. At the theoretical level, Gestalt psychology research has also demonstrated that spatial similarity and legibility help people to accomplish way finding tasks.[8]

In summary, this research will use one of the

1. Meeks, C.L.V, *The Railroad Station, an Architectural History* (New Haven: Yale University Press, 1975), 5.
2. Ibid.
3. Yo Kaminagai, "Intermodal hubs as urban spaces," in Stations as Nodes: Exploring the Role of Stations in Future Metropolitan Areas from a French and Dutch Perspective, ed. Triggianese(editor) et al. (Delft: TU Delft Open, 2018), 33.
4. Ibid.
5. Ibid.
6. Lynch, Kevin, *The Image of the City* (Cambridge, Mass: MIT Press, 1997).
7. Jerry Weisman, "Evaluating Architectural Legibility: Way-Finding in the Built Environment," Environment and Behavior 13, no. 2 (1981): 189–204.
8. Niu Li, Xu Leiqing, and Tang Zhong, "Use of gestalt in wayfinding design and analysis of wayfinding process," Frontiers of Structural and Civil Engineering 2. No.4 (2008): 386-390.

multi-modal stations in Berlin as a design practice to explore how architectural space can guide or help people find the correct path and thus shape an efficient and convenient station.

1.2 Problem Statement

In Berlin, the public transportation system is large and varied. Train (S-Bahn), tram, metro (U-Bahn), and bus consist of the main skeleton of the system. Hundreds of stations are scattered within Berlin's central area and other satellite towns. However, according to tom-tom's survey data, Berlin is still the third most congested city in Germany in terms of vehicle roads.[9] It is indeed very difficult for a metropolis of about 3.6 million people to handle the huge number of daily commuters and tourists, but with such a large number of public transport stations, a very congested city centre is unacceptable. By mapping the Berlin high congestion road and areas with the most emissions, congested areas in urgent need of improvement have been found. We identified that these congestion areas are located in places that lack inter-modal transfer hubs and most of them are located in eastern Berlin's tram network area. From this point of view, there is a definite connection between inter-modal hubs and urban road congestion in Berlin. Looking at other EU cities, multi-modal stations are indeed an effective solution to combat motor vehicle use because it provides a more integrated and sustainable transportation model.[10]

It is possible to develop a new multi-modal train station in Berlin, but its specific spatial structure needs to be based on a convenient experience. This is because multi-modal stations have various scales and types of space forms inside. If passengers cannot quickly find an efficient transfer route, it will instead increase congestion and reduce efficiency. This is particularly a challenge in the context of Berlin's current fragmented public transportation system and the high-density urban environment of the city centre. Besides, the last mile in a public transportation trip is known to bring a large disutility to passengers.[11] Conventional bus operation mode still has unpredictable waiting time and space separation for transfer.

1.3 Research Question

The core and inevitable topic in the design of inter-modal stations is how to achieve a seamless transfer experience. The objective of the transfer hub design is to optimize transit times for different modes of transportation while ensuring that passengers are able to spend their travel time in a pleasant or useful manner.[12] Thus, the organization of both different functional spaces and the flow of people should be focused on. The spatial experience can be influenced by architectural elements such as skylights, atrium, materials, and so on while experience and perception directly decide the judgment of users when finding routes. In the digital life of the future, signage is likely to become increasingly complicated and carry large amounts of data and information. Yet the architectural space probably serves to simplify and provide a natural way-finding guide for passengers. In this case, exploring the relationship between space and natural way-finding becomes more essential in the design of a multi-modal transfer hub. How architectural spaces can guide people to find routes at multi-modal transfer stations? What are the relationships between the spatial experience and signage design in the future? What the future space organization will be like at multi-modal transfer stations?

In addition, the project aims to represent an inspiring example that can contribute to a more sustainable future transportation mode.

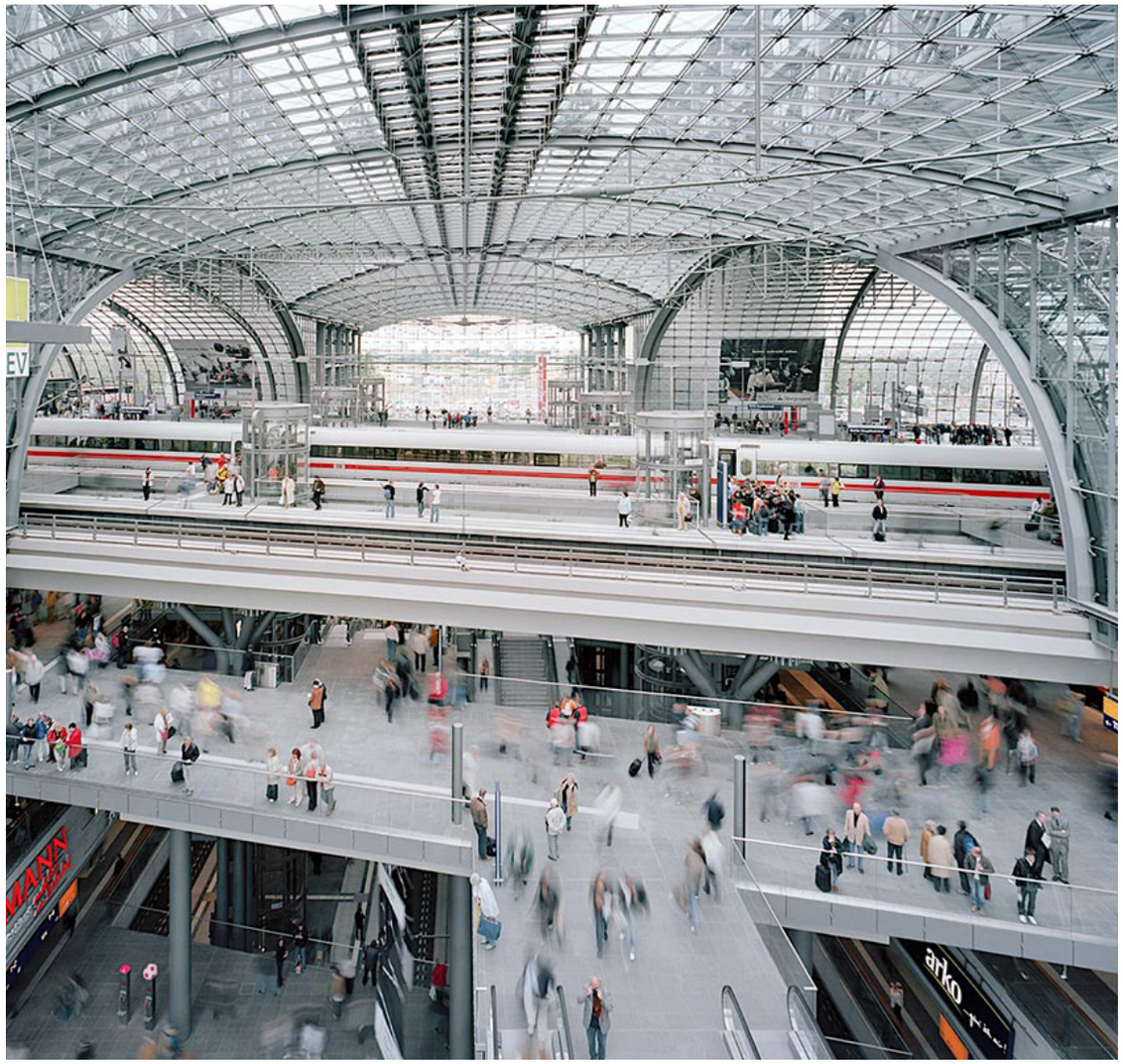

Figure 1. Interior of Berlin Hauptbahnhof. Retrieved from https://wsdg.com/projects-items/berlin-hauptbahnhof-central-station

9. "Ranking of congestion index in German cities," Tom-tom, accessed November 3, 2022, https://www.tomtom.com/traffic-index/berlin-traffic#statistics.
10. Adamos, Giannis, and Eftihia Nathanail, "How Attractive are Public Transport Interchanges? A Cross Comparison of Two European Terminals," Transactions on Transport Sciences 13, no. 1 (2022): 74-83.
11. Arthur Scheltes and Gonçalo Homem de Almeida Correia, "Exploring the use of automated vehicles as last mile connection of train trips through an agent-based simulation model: An application to Delft, Netherlands," International Journal of Transportation Science and Technology 6, no.1 (2017): 28-41.
12. Fatemeh Torabi Kachousangi, Niels van Oort and Serge Hoogendoorn, "The Future of Intermodal Hubs," in *Stations as Nodes: Exploring the Role of Stations in Future Metropolitan Areas from a French and Dutch Perspective*, ed. Triggianese(editor) et al. (Delft: TU Delft Open, 2018), 57-58.

THEORETICAL FRAMEWORK

02

2.1 Theoretical Framework

The theoretical framework will be based on the theories of architecture and its intersecting disciplines, including Gestalt psychology, theories of perception and legibility of space, theories of spatial orientation and way-finding, etc. In addition, it includes a historical development and a modern typological study on multi-modal railway stations.

Jerry Weisman evaluated the correlation between architectural legibility and way-finding systems through questionnaires and analysis of two-dimensional plan diagrams and argues that spatial readability facilitates the way-finding process and results in a variety of different behaviours.[13] On the basis of Jerry's readability study, some scholars brought forward a new definition named "Gestalt space".[14] Spatial classification, grouping, and interruptions are also significant basic strategies to accomplish way-finding design. Besides the study of way-finding and legibility, the sensory experience of space is another theoretical research direction. Paul and Romedi explained the importance of graphics, auditory and tactile to the way-finding design and how signage and architectural components work together to facilitate way-finding systems.[15] In a subsequent study, Jason illustrates more concretely how graphic indicators and spatial structures work together to define spatial characteristics and establish way-finding order through a specific architectural renovation case in Amsterdam.[16]

For the building type of multi-modal transfer station, the integration and interconnection of multiple traffic modes are bound to a more complex flow inside the building than in a conventional train station. Therefore, before investigating the way-finding system inside the multi-modal transfer station, it is essential to analyse both the spatial hierarchical organization and critical spaces. Edwards summarized six main elements of designing which respectively are railway tracks, platforms, circulation areas, ticketing, parcel areas, and concourse.[17] These key spaces of the building are interconnected and influence each other. Based on these, in the subsequent case study, the spatial relationship between railroad track and concourse, parcel area, and concourse will be used as the main theme to be compared by means of a relationship diagram. The summarized relation diagram is graphically shown below(Fig.2).

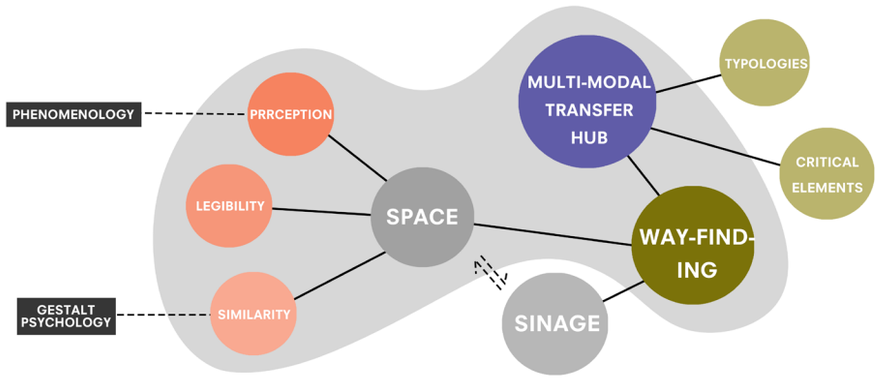

Figure 2. Relation diagram of theories connection. Illustration by author.

13. Jerry Weisman, "Evaluating Architectural Legibility: Way-Finding in the Built Environment," Environment and Behavior 13, no. 2 (1981): 189–204.
14. Niu Li, Xu Leiqing, and Tang Zhong, "Use of gestalt in wayfinding design and analysis of wayfinding process," Frontiers of Structural and Civil Engineering 2. no.4 (2008): 386-390.
15. Arthur Paul and Romedi Passini, *Wayfinding: People Signs and Architecture* (New York, McGraw-Hill Book, 1992).
16. Abrams, Jason Brandon, "Wayfinding in Architecture," (2010) *Graduation Theses and Dissertations*.
17. Edwards Brian, *The Modern Station: New Approaches to Railway Architecture 1st ed* (London, E&FN Spon, 1997).

RESEARCH METHODS

03

3.1 Program

In order to reach the conclusion and establish a comprehensive design brief for further design, the architectural program has to be the most significant part to set a clear list of various functions and uses. This list should include the area proportion of rooms for each function, the estimated number of users in each functional area, and the ratio of gross floor area and net floor area. In particular, in a multi-modal transfer station, due to the different distribution characteristics of transportation modes, the proportions of the area of each traffic mode to the total footprint also need to be defined and compared. In addition to the program bar, the relations or intersections between the functional areas should be explained in a clear graphical way.

Nevertheless, all the analyses and conclusions of the architectural program are still aiming to design a multi-modal transfer station in Berlin with an effective natural way-finding system by spatial design. Thus, case studies and benchmarking will be used to figure out the size and program bar of the project. The average ratio figure will be calculated and then fine-tuned to the specifics of the project. During the process, archives, books, and online materials will be accessed. For those statistics which cannot be reached from existing information, floor plan and section drawings will be collected and areas of each functional room will be traced by the author through the software adobe photoshop, or illustrator. Afterward, excel will be used as the data processing and calculation tool. For relation diagrams, the specific analysis themes should be first defined for the multi-modal transfer station. In this case, relations between the concourse and tracks, the building and tracks, and the concourse and entrances were chosen as three main topics. Through the comparative analysis of these topics, the flows of different groups of users or logistics will be clearly defined. They are graphically visualized as flow chart diagrams while vertical and horizontal intersections will be marked as important nodes.

3.2 Client

According to the investigation data from Allianz pro schiene, only one-fifth of station buildings still belong to the federal government and Deutsche Bahn.[18] Most of them were sold to private associations or companies after the German rail reform. However, as the Pro-Rail Alliance managing director criticized, "*Too many of the reception buildings sold are in an unsatisfactory condition today, many can no longer be used for travellers.*"[19] The segregated ownership of reception buildings and traffic platforms results in a chaotic and inefficient management model which hinders the long-term development of multi-modal transport stations.

Based on this preliminary conclusion, the following studies on clients need to focus on the ownership of reception buildings and traffic platform buildings. Besides, the benefits of other stakeholders like the micro-mobility, sharing, and electrical transportation providers should be taken into account as well. Regarding the specific methodology of the investigation, first of all, it is necessary to continue to collect online information from both railroad companies and professional survey agencies. Secondly, the most critical needs and concerns of clients can be obtained through direct interviews or email contact if possible.

3.3 Site

The site studies will be approached in two phases. Station mapping as well as traffic data collecting will be processed in the first phase. This helps the author to gain a general understanding of Berlin's traffic conditions and eventually define an approximate area. Then the fieldwork will be conducted

18. "Only every fifth station building still belongs to DB," Allianz pro schiene, accessed November 11,2022, https://www.allianz-pro-schiene.de/presse/pressemitteilungen/nur-jedes-fuenfte-bahnhofsgebaeude-gehoert-noch-der-db/.
19. Ibid.

03 RESEARCH METHODS

including drawing sketches, taking photos and doing interviews, etc. Field experience in taking various modes of transportation in person is also a good way. Strolling maps and sketches of critical spaces and nodes in sites will be drawn as well during the experience.

DESIGN BRIEF

04

The fourth chapter of the research plan will only serve as an outline for the design brief while also being divided into three aspects to explain which are program, client, and site. In addition, possible outcomes and conclusions to be developed in the next phase will also be mentioned in this chapter. Besides, the case study is an important generic method to reach conclusions in all three aspects. Reference projects with various scales and sizes were selected which are Anaheim multi-modal transfer hub, Kyoto station, Berlin Hauptbahnhof, Stratford station, and Arnhem central station respectively.

4.1 Program

The initial program scheme consisted of the program bar and relation diagrams. According to the research methods, the area proportion was calculated and compared. The program bar of the design project is mainly based on the average value to determine the approximate proportion of each function and then adjusted by the particular design ambitions or needs. In order to develop a station that can provide a seamless and efficient transit experience through natural way-finding, circulation, and concourse areas become the most focused points. Thus, their proportion has increased correspondingly. For the initial program bar sees figure 3 below. A relation diagram was drawn by using benchmarking and analysis of references. For the initial relation diagram sees figure 4.

Except for the program bar, other significant statistics need to be defined in further phases. For example, the estimated number of users in each functional area and the ratio of gross floor area and net floor area are key elements to figuring out the size, scale, and footprint. In addition, the quantity and types of transportation modes (including regular and added ones) have to be confirmed. Regarding more detailed and technical issues, the length and width of platforms and tracks should also be investigated by case studies. Other critical numbers that may influence the platforms like track gauges and safety distance can be accessed by literature.

4.2 Client

The clients are initially divided into two groups: service providers and operators of conventional transport such as railroads, trams, and subways, and service operators of micro, sharing, and electric transport. Deutsche Bahn AG the most important railroad-operating company in Germany was defined as the main client whose ambition was aiming for a more sustainable, more climate-friendly, and more mobile German rail network.[20] Another conventional transportation operator in Berlin is Berliner Verkehrsbetriebe (BVG) which is responsible for managing the city's U-Bahn underground railway, tram, bus, replacement services, and ferry networks. BVG is also an explorer who is seeking an electric future for Berlin by promoting more electrical public transportation.[21] Most of the other relevant clients are emerging and innovative traffic operators who are providing sharing, on-demand, or electrical mobilities like Lime and Tier. An integrated and complex station is of course a prerequisite for these clients but what are the detailed demands or ongoing bottlenecks have to be explored in the next phase.

4.3 Site

By mapping stations, analyzing original-destination traffic maps, and investigating public transport passenger volume within Berlin's city center, the congested area was defined graphically (Figure 5). And the first conclusion is that most congested areas are located in either complementary areas to existing transfer hubs or existing tramway network areas. Thus, in order to achieve ambitions, site selection should focus on the areas where there both are congested and disconnected.

The potential sites were eventually narrowed down to three places which are Warschauer Street, Hackescher Markt, and Ostbahnhof. However, in order to make the ultimate decision, more detailed information on the surrounding urban environment, cultural context and etc. should be done during the fieldwork.

20. "Our inner ambition," DB Integrated report 2020, accessed November 13, 2022, https://ibir.deutschebahn.com/2020/en/group-management-report/strong-rail/our-inner-ambition.
21. "Set to electrify your ride," BVG Info, accessed November 13, 2022, https://unternehmen.bvg.de/electromobility/.

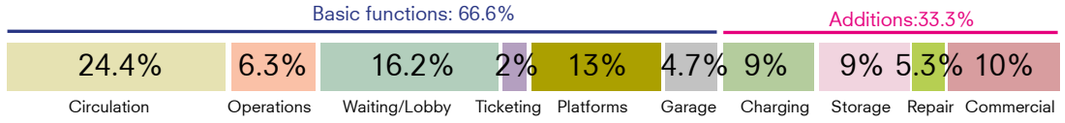

Figure 3. Initial program bar. Illustration by author.

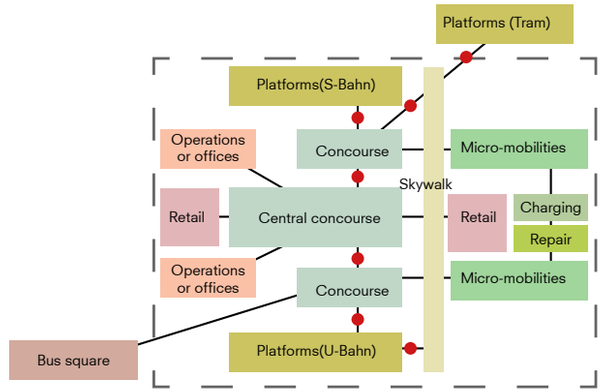

Figure 4. Initial relation diagram. Illustration by author.

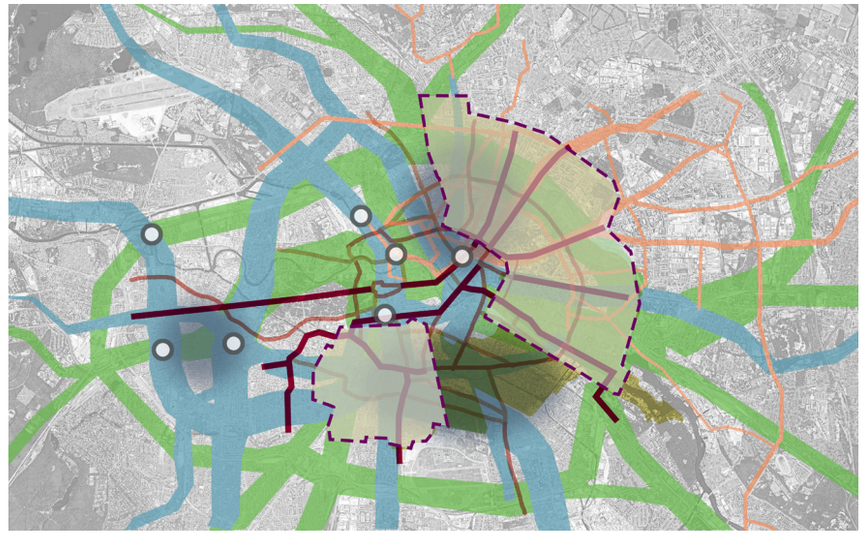

Figure 5. Potential site locations in central Berlin. Illustration by author.

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05

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