



RUSH HOUR

THE TRAIN STATION AS THE FUTURE DATAPORT

P4 REFLECTION PAPER

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ASPECT 1:

the relationship between research and design

The primary objective of my graduation project is to present a design proposal at P4 and P5 that addresses my research topic: *'How data will impact the design of a train station during rush hour?'*. In essence, this involves exploring how data could game-change the building's function and appearance in the future.

Data has significantly influenced both the research and design aspects of the project. We live in a rapidly evolving society, inundated with accessible information and emerging technologies. Architects, beyond being master-builders, are master communicators, translating societal needs into tangible concepts that materialise as spaces, forms, and expressions. Balancing functional requirements with emotional and experiential elements proved challenging, underscoring the importance of designing from both inside-out and outside-in perspectives. This tension between contrasting research and design methods often led to more innovative results, enriching the design process and pushing boundaries.

I learned that design should be informed by research, with the design process serving as a means to explore and validate ideas. In the first semester, an extensive amount of data was gathered on existing train station typologies, as well as on relevant context, such as client needs, future trends, and the advent of new technologies like automation and the influence of data on society. All this research impacted the design to varying degrees, and the findings were synthesised into a design brief presented at P2. It was crucial to clearly define the client's requirements for the programme and site. A strong vision is an essential starting point for the design phase in the second semester, bound by certain design parameters and restrictions (GFA, dimensions, spatial relationships between functions, etc.).

After P2, the relationship between design and research became even more intertwined. Data

and research are simply tools for architects and do not entirely shape the building. Design was therefore employed as an exploratory research tool to generate various proposals. This process, termed 'research by design', involves trial and error, with options evaluated based on how well they meet the design brief's requirements. This led to a non-linear process of convergence and divergence, exploration, and refinement.

After P2, I realised I had focused a lot more on the train station typology rather than exploring the role of station as a dataport with programmes such as data centres, makerspaces, and libraries. This knowledge gap resulted in a more narrow-minded approach until P3. Later in the design phase, I recognised the need to gather new data, for example, on the structural dimensions of data centre spaces, safety and security aspects, and potential architectural expression of data-driven spaces. In the design stage I used parametric design for generating geometric dome structure or created CGI visualisations which would be much more complex tasks without these new technologies.

ASPECT 2:

the relationship between the graduation topic and studio topic

The relationship between my graduation topic and our studio's theme, "Bodies and Buildings in Berlin," lies in the shared exploration of how societal changes influence architecture.

The studio aims to understand how shifts in society shape the design of public buildings, focusing on urban context (site), programmatic needs (programme), and client ambitions.

The studio offered nine public building typologies, categorised into flow, place, and space types, to help students analyse them more systematically. For my graduation project, I chose the train station, which is considered a centre of movement in cities, especially during peak periods, commonly referred to as rush hour. Additionally, each project group, consisting of

nine students with nine different typologies, was assigned a societal lens. In my case, it was digitalisation. As digitalisation increasingly blurs the line between the physical and digital worlds, architects must adapt.

Despite data being omnipresent in our daily lives, it has yet to be fully integrated into our built environment, except in the form of large, anonymous data centres on the periphery. My graduation project explores how data infrastructure can be merged with another complex infrastructure, the train station, in a single public building. Could the station also serve as a large public data centre with people as data agents arriving and leaving by train or just passing-by? Not as two separate entities, but as one integrated structure, metaphorically, programmatically, or even literally, with data storage and exchange incorporated. The project experiments with this idea, investigating the advantages and disadvantages of merging both types of common good infrastructure.

The train station offers physical accessibility, while a data centre provides digital accessibility. This combination could transform the building into an innovation hub and centre of urban life, where people interact with both one another and information. There could also be circular energy exchange (reducing heat waste), and processes such as passenger flows and logistics could be fully automated by artificial intelligence. Furthermore, the building can be a communication interface with the city and its users while the pass the station from the inside and outside.

ASPECT 3:

research method and approach chosen by the student in relation to the graduation studio

The research method and approach were heavily influenced by the framework of the studio. Typically, a design brief serves as the starting point, but in the Complex Projects studio, we were tasked with developing our own brief. This involved a thorough study of the programme, client, and site, culminating in a presentation at P2, which became

the foundational guideline for subsequent stages. In the second semester, we translated our academic work into a tangible concept, design, and materialisation, shaping an architectural proposal for P4.

The matrix-like methodology of the studio was well-structured and helped organise my research and design process. Developing a clear design brief allowed me to refer back to the requirements whenever I became side-tracked. This was particularly useful for me, as I tend to get overwhelmed and diverge too easily. Additionally, the evidence-based approach, including benchmarking the design with data from case-study train stations, helped develop a logical and rational project. I believe the studio serves as an excellent stepping stone for my professional career. With complex projects like train stations, the stakes and design criteria are equally complex. An architect who can extract, manage, and process data has a powerful skill set, especially when proof-of-burden is required by the client. This approach casts architecture and design in a more scientific and objective light.

The focus on digitalisation in the graduation project was integral to the studio's framework, receiving significant attention throughout. It provided a strong lens through which to view the building typology, helping to reinforce and refine the key concept. However, there was a constant risk of becoming overly fixated on the digital aspect and neglecting other important design objectives such as health, energy efficiency, and circularity. It was crucial to understand that these aspects were not mutually exclusive.

Through the digital lens we decided to integrate a data centre. We speculated that all urban public buildings should have a responsibility to contribute to data infrastructure by storing data. This formed a city-wide urban strategy known as the 3Ds: Decentralising data centres, Displaying data centres, and Decarbonising data centres. Together, our projects created a network of data-driven buildings that impacted the city both locally on our sites and regionally.

We also aimed to materialise data and give it prominence. As a group, we collectively researched the requirements (structural dimensions, safety, security, energy flows, etc.), but the actual implementation was shaped by individual approaches, depending on the typology and level of publicness.

Between P2 and P4, the project shifted from academia to practical application. The goal was to translate the design brief into a concept and design that addressed the research question. The architectural response needed to address everything from the urban scale down to 1:5 building details.

Data display and connectivity is both present on the inside and outside. For example, at the urban scale, I defined a chain of 3 circular buildings that form an urban connection in the city while focusing attention on the train station internally. At the building level, the data centre is positioned within the core, ensuring it is both secure and visible. At the detailed level, the outer façade is a shell of ETFE cushions with automated air pumps controlled by the data centre to regulate the internal climate. The ETFE shell also integrates PV cells to generate energy for the station, and LED lights to communicate with building users and passers-by.

ASPECT 4:

relationship between the graduation project and the wider, social, professional and scientific relevance

At TU Delft, innovation is key, and this graduation project reflects that by offering an academic approach with a station database and methodology. This resource is valuable for academics, students, and professionals working on various research and design projects. Train stations play a vital role in people's daily lives and society, and this project aims to demonstrate how they can lead the way in circularity and technological advancement.

The project deliberately speculates that train stations can transcend their traditional role in passenger transit. They can become

innovation hubs where people, data, and resources intersect, driving urban life forward. Leveraging digitalisation, the future station should handle peak flows more effectively while enhancing efficiency and user experience.

The priority is to explore a 'game-changing' building typology rather than strictly conforming to current standards for train stations. This may result in a more or less efficient structure—we won't know until tested—but the design proposal undoubtedly offers new academic insights and raises awareness about typology innovation. While the train and platform are generic components of the station, integrating a data centre into this equation could attract additional programme types, such as commercial shops, makerspaces, offices, recreation spaces, or even a botanical garden. This would allow the station to serve as both a transit node and an urban anchor, where people come not just to commute, but as part of their daily lives.

By studying existing train stations and exploring the impact of data, the project addresses a significant knowledge gap in the built environment. Data is often seen as purely digital, but this project aims to give it a physical presence by integrating it within an existing building typology and site. The project responds to societal dynamics by reimagining the station and data centre as a multipurpose typology, increasing the publicness of the building and enhancing its use compared to older, single-purpose designs. It recognises the need for architects to adapt to the digital age, as highlighted by the recent addition of an AI department at TU Delft's Faculty of Architecture.

ASPECT 5:

ethical issues and dilemmas you may have encountered during graduation

The chosen title of "rush hour" was given me a frequent dilemma throughout the project. Was the design meant to prioritize efficiency, resembling a machine-like building for rush-hour commuters? Or was the station

envisioned as a hub of innovation, facilitating the exchange of data, people, and resources? Or it can be both as it not only commuters in rush, all users can be in rush and resting at various times during the day. I had to constantly remind myself that I was designing for a range of stakeholders, including end-users, the EU, Siemens, and the municipality, not just the Railway operator Deutsche Bahn. The ultimate goal was to find a design proposal that aligned with shared ambitions documented in the design brief.

Considering the overall efficiency beyond the building scale, especially within the context of the entire city of Berlin, it made sense to transform the station into a multi-system node to promote future circularity rather than creating a misalignment between flows. This would mean a strong paradigm shift.

Adding a train station of such proportions and scale raises many ethical issues in terms of sustainability as it could potentially stimulate further growth and travel demand, pushing the limits of our environment. Therefore, it was important to consider the urban development around the station as an integral part of the project. A vision of transit-oriented development, featuring a compact, walkable district evolving around the station, where urban flows remain predominantly local while data travels globally, could be a positive step in minimizing the large-scale carbon footprint.

Concerns arise regarding building carbon emissions, balancing concrete and steel for longevity against bio-based materials for their temporality poses a constant dilemma. Designing a building that's both modular and adaptable yet monumental is challenging. Creating a timeless structure accommodating rapidly changing digital needs adds complexity. For instance, including physical data storage as part of our digitalisation group requirement raises questions about its carbon footprint and future redundancy. Designing spaces to adapt to evolving forms of data storage presents a significant design challenge.