# Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

| **Personal information** | |
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| Name | Minseong Kim |
| Student number | 5202612 |

| **Studio** | | |
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| Name / Theme | City of the future | |
| Main mentor | Dr.ir. M.G.A.D. (Maurice) Harteveld | Urban Design |
| Second mentor | Dr. C.E.L. (Caroline) Newton | Spatial Planning |
| Third mentor (CotF studio) | Dr.ir. J.H. (John) Baggen | Transportation planning |
| Argumentation of choice of the studio | The key themes of my thesis concern the realistic use of (often hyped) vehicle automation technologies in the cities and their impacts. Therefore it involves different disciplines (transportation planning and urban planning), and the assessment of the impacts of technology. I believe this is well-aligned with the cross-disciplinarity and technology focus of the studio. | |

| **Graduation project** | |
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| Title of the graduation project | Post-Spartacusplan: Exploring the future possibilities of bus rapid transit (BRT) for spatial and mobility transition in Euregio Meuse-Rhein |
| **Goal** | |
| Location: | Province of Limburg, Belgium; in the context of EU INTERREG Euregio Meuse-Rhein |
| The posed problem, | 1. The Belgian Nebular city<br>The haphazard development of the Belgian countryside made Belgium the second most sprawled country in Europe. The dispersed settlement pattern of the Belgian countryside occurred through the dispersion policies of the 19$^{th}$ and 20$^{th}$ centuries, facilitated by the transport infrastructures. This dispersion resulted in higher costs in providing sewage, water, electricity, and other public services and infrastructures, and poses greater challenges in water management, biodiversity, access to open space, and sustainable energy production. This form of urban form has been especially devastating in the provision of public transport services, where the severely low street connectivity and low density around the nodes combined with the longer distance of roads to cover have made the costs of providing public transport services in the dispersed region unreasonably high.<br><br>Many solutions have been proposed to remedy this through the existing framework of “compact city” ideals, in forms such as selective |

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| | densification or infill development. However, such solutions are criticised for being unrealistic or inapplicable to the realities of the Belgian countryside, and therefore there are calls for better solutions suited to the unique situation and the context of Belgium.<br><br>2. The death of Spartacusplan<br>Belgian Limburg lacked a proper rail network due to its peripheral location at the border, and the relatively delayed period of population growth following the mining and industrialization resulted in severe car dependency and connectivity in the region. Moreover, the national border divides the region's major destinations, and differences in the rail infrastructure and inadequate coordination have hindered the creation of a viable public transport network in the region.<br><br>The transport plan of Belgian Limburg in 2004 called "Spartacusplan" has proposed 3 light rail lines (Spartacuslijn 1, 2, 3) connecting major cities inside Limburg and cross-border destinations of Maastricht, and possibly Sittard-Geleen and Eindhoven. As of 2023, none of them has been realised, and all light rail plans have been switched to bus rapid transit (BRT), due to low expected ridership and failure to integrate into existing urban fabric and infrastructures. Whether this decision was a good choice is still a subject to discussion, but it is clear that the starting point of the decision is not based on the inherent key characteristics of BRT; for now, the switch merely took place by replacing the light rail into a BRT system using bi-articulated "Trambuses". Whether applying the Spartacusplan's light rail framework on BRT can sufficiently take the strengths (flexibility) and weaknesses (long-term operating costs, preferences…) of BRT into account or not needs to be figured out.<br><br>3. The promise and reality of driverless vehicles<br>In the North American sprawl context, speculation over the use of the autonomous vehicle in both private vehicles and public/shared transport has been taking place. However, in the last couple of years, the promising image of driverless vehicles has been breaking down rapidly. It is now predicted that the fully driverless vehicle under all conditions (SAE level 5) will not be possible in the near future, and for personal vehicles, Level 4 (fully driverless in limited conditions) will also take significantly longer to realise.<br><br>This calls for three things: First, the implementation of an autonomous public transport system should be connected with the interventions in infrastructure design, in which controlling the environment where the autonomous vehicle may operate plays a central role in it. Second, future perspectives on the sober, realistic application of vehicle |

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| | automation are needed, away from the currently predominant rosy views on a fully driverless future in the cities.<br><br>4. Deindustrialisation and "Concrete stop": Compacting the Flemish countryside<br>Due to the aforementioned issues with dispersion, the Flemish government has set a timeline until 2040, when no more extra land will be taken away for development. As for the people living in the dispersed settlements, which accounts for ¼ of the whole Flemish population, this policy has made clear that shrinkage at the local level will be a certainty in the future; and in the context of Limburg, the current process of de-industrialisation will add more challenges in liveability in such neighbourhoods. |
| research questions and | Main research question:<br>How can we use the innovations in autonomous vehicles to implement a just transport network in Belgian Limburg and Euregio Meuse-Rhein that can help in tackling the spatial challenges in the area?<br><br>The 3 fields of Spatial/Justice/Mobility aspects are noted as S/J/M each.<br><br>1. Theoretic sub-questions<br>o (S/J/M) How the "just" mobility transition should be, and how can it be approached in the context of Flemish Nebular city?<br>o (S/M) How can a transport infrastructure contribute to the goals of spatial development accordingly?<br>2. Analytic sub-questions<br>o (S/M/J) What should be prioritised in the design of spaces and services, and what, and where are the immobile groups that need to be prioritised?<br>o (S/M) What are the opportunities for tackling spatial challenges through nodal interventions?<br>o (S/M) What is the movement pattern of Limburgers, and how can it be translated spatially?<br>3. Design & strategic sub-questions<br>o (M) What will be the ideal mix of transport technologies, and what will be its spatial impact?<br>o (S/M) How to integrate the goals of tackling spatial challenges into the process of implementing the (automation-ready) public transportation infrastructure?<br>o (J) How to better involve the public in the design process and better translate their experiences and knowledge into the design process? |

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| | The hypothesis of the research questions is as follows.<br><br>**Main RQ**:<br>The flexibility of routing and service pattern of BRT is an ideal strength to provide service to underprivileged (immobile) areas and groups; The challenges in the operating costs will be tackled through the adoption of autonomous vehicles.<br><br>As suggested through several design exercises in recent years, notably that of S. Leemans, infrastructure space and underlying systems have immense potential in tackling the spatial challenges in the context of Sprawl in Europe. I expect this to be possible through the (both nodal and linear) space that is needed for the realisation of the (semi-)autonomous transit system can be given diverse functions other than being a buffer for the movement space.<br><br>1-1 / 1-2:<br>The hypothesis for the theoretical questions is included in the theory paper.<br><br>2-1:<br>This question will be answered further through the design process #2-1. The principle of transportation justice has been already laid out to focus on groups experiencing accessibility under certain thresholds. Regarding the identification of the immobile groups, as of now, I expect the dispersed countryside to have a higher number of immobile people.<br><br>2-2:<br>This question will be answered further through the design process #2-1. I expect that the linear character of infrastructural in-between spaces and the central character of nodes may provide a widespread impact.<br><br>2-3:<br>This question will be answered further through the design process #2-2. I expect the visual methods of time-space geography will be able to capture the (often informal) movements spatially.<br><br>3-1:<br>This question will be answered further through design process #3. As of now, I expect that level 4 may be too demanding infrastructurally, so, therefore, level 3 including V2V capabilities (platooning) would be the best mix given the settlement patterns of the area. |

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| | 3-2:<br>This question will be answered further through design processes #5 and #6. I expect the linear infrastructural in-between spaces to be used as a distribution tool and the nodes to be a public space. Also, the impacts of the public transport provision can be utilised as leverage in achieving the spatial goals in the process.<br><br>3-3:<br><br>This question will be answered further through design processes #5, 6, and 7. I expect that the use of pattern language as a communication tool can build capacity and therefore help achieve this goal. |
| design assignment in which these result. | The design exercise will be expected to go into implementation in the near future (2030), and its impacts lasting over 30 years from that (2060). The ultimate aim of this project is to propose a model of sustainable and just way of implementing BRT by using an achievable level of vehicle automation, in place of the currently planned "Trambus". The design should be combining the (spatial) implementation of Spartacuslijn BRT with both spatial and transport challenges as illustrated in the conceptual framework (see figure 1). The opportunity for tackling such challenges should be maximised, and the effects of the transport service shall be used as leverage. The design should also coordinate the spatial needs accordingly :<br>• Space for infrastructure provision<br>• Space for movement<br>• Space for ecosystem and biodiversity<br>• Space for energy production<br>• Space for leisure and tourism<br>• Space for living<br>• Space for water management<br><br>The spatial interventions will concern areas related to the realisation of the Spartacuslijn 1 ~ 3, including nodes, public spaces surrounding it, streets for accessing the nodes, neighbourhood improvements, in-between space, corridor space, and vehicles. The effect of the intervention should result in all scale levels.<br><br>The design project aims to provide a future perspective and framework for implementation through public participation. In order to test the efficacy and applicability, a spatialised plan on selected locations should be made by applying the toolbox. This will also provide a "recommended scenario" for the further operationalising of the project. |

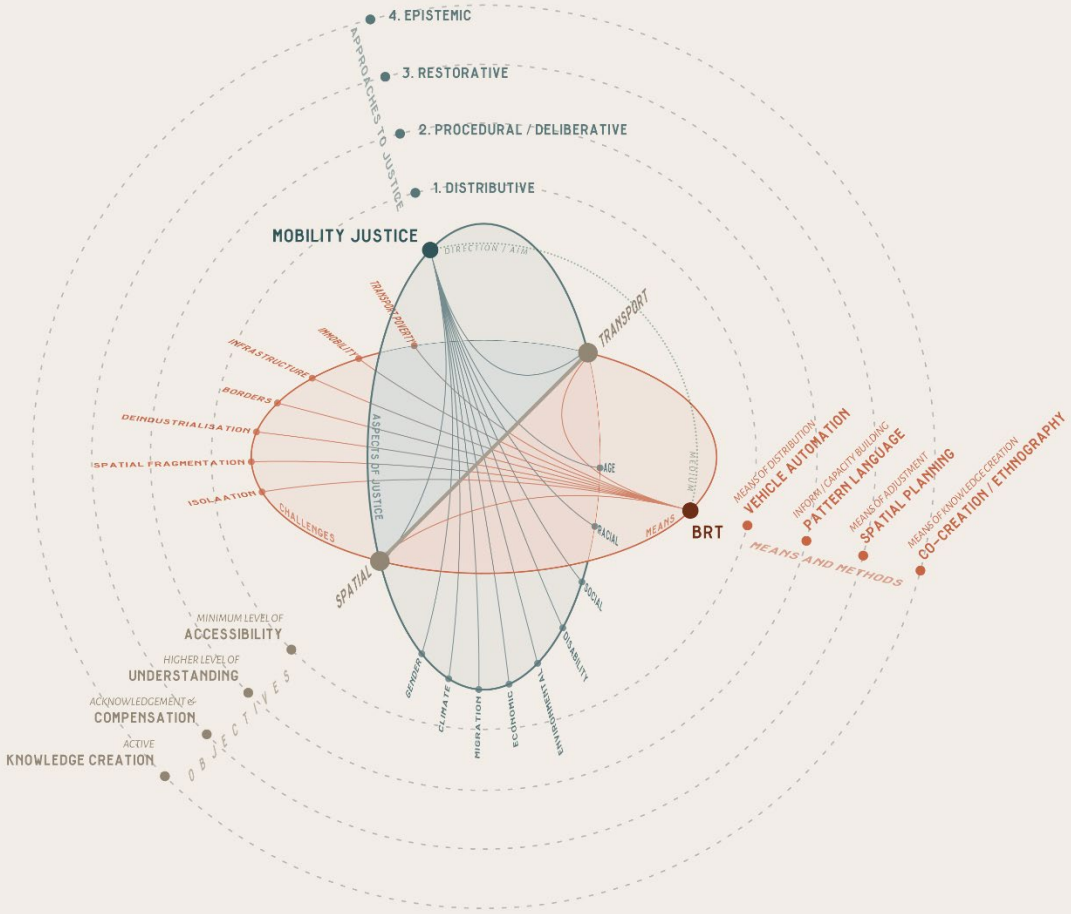


*Figure 1: Conceptual framework*

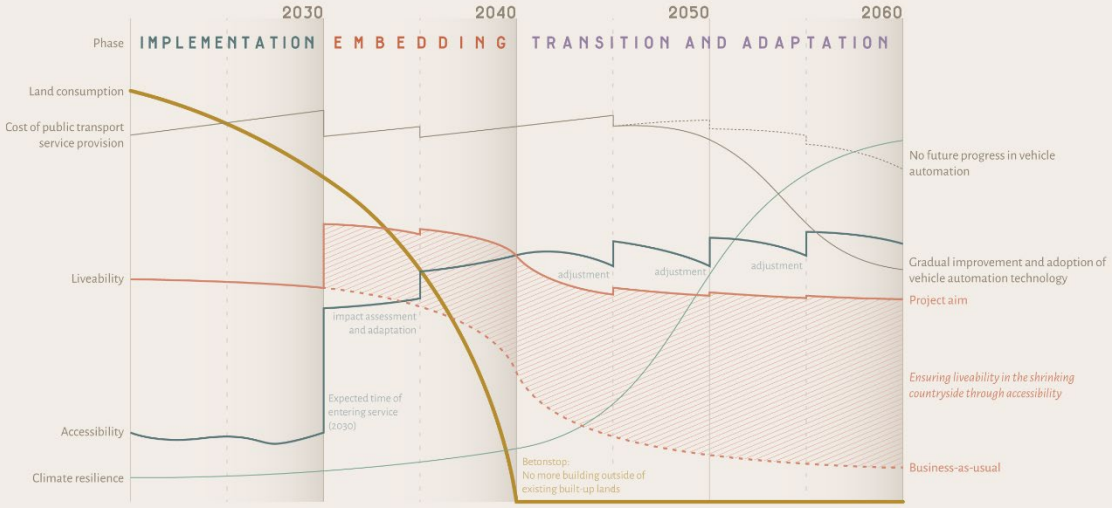


*Figure 2: Timeline of the concept*

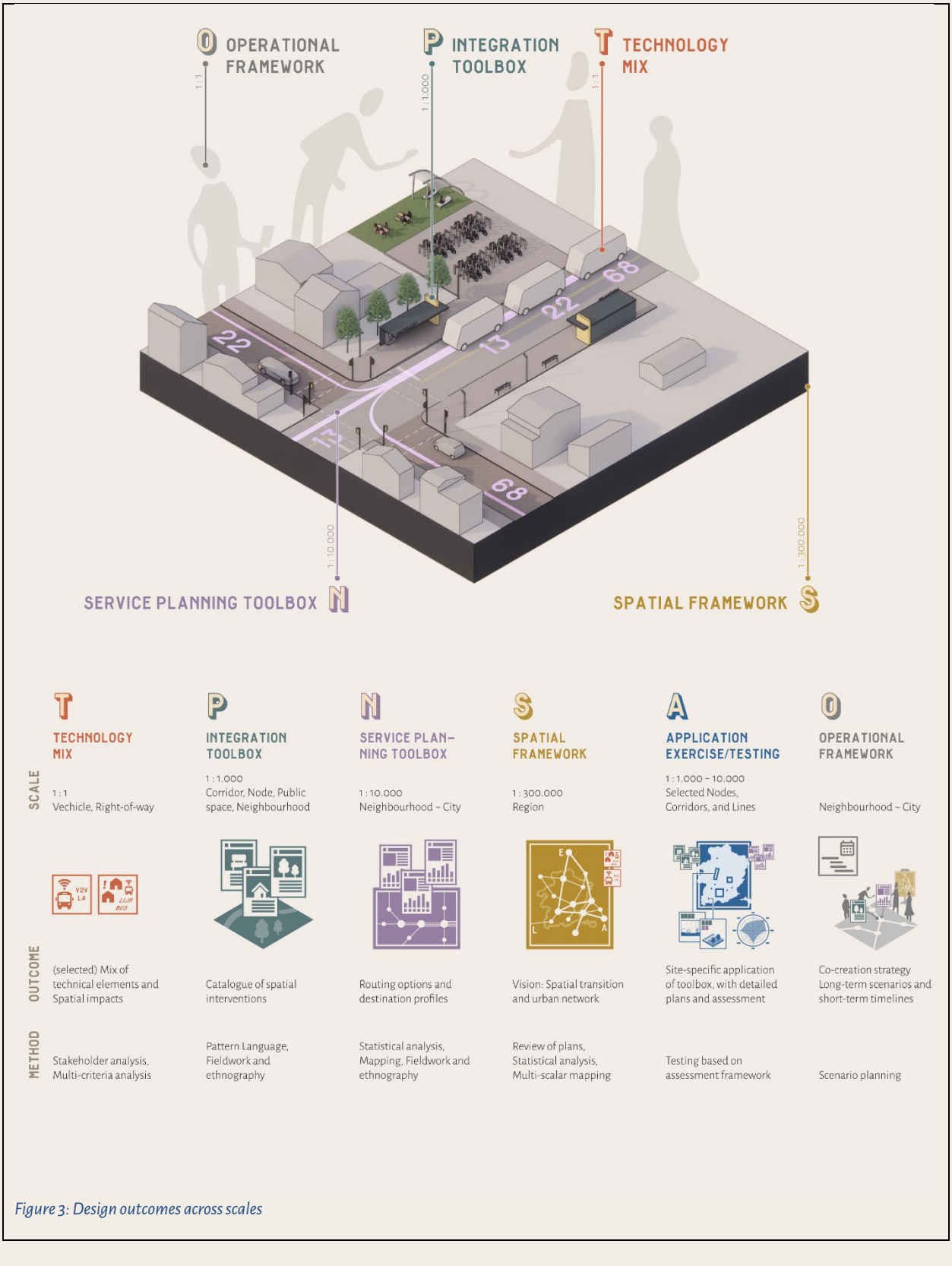


*Figure 3: Design outcomes across scales*

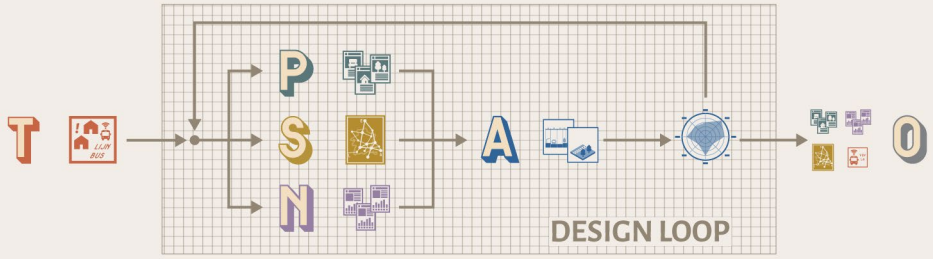


*Figure 4: Design exercise flow*

## Process

### Method description

**1: Literature review**

The literature review is conducted on 3 dimensions: First is to read the current Flemish spatial situation in relation to mobility and its proposed solutions. This constitutes the basis of the viewpoint towards the Flemish countryside. The second dimension consists of pieces of literature setting the over-arching direction of the project, which is focused on accessibility and aspects of justice related to mobility. The third dimension concerns the approach and means. Key documents used in the Literature review are cited on the next page.

Outcomes: Theory paper (Already made), Evaluation criteria

1-1: Stakeholder analysis and review of existing plans/policies

A stakeholder analysis through existing policy documents and plans is also conducted, to analyse the wishes and requirements of the project.

Outcomes: Wishes/requirements analysis, which will be used in step #3. (Already made)

**2: Analysis**

2-1: Spatial analysis

The analysis of spatial, socioeconomic, and environmental aspects will be conducted to identify the immobile groups and locations, and also look for opportunities, challenges, and restrictions in tackling the spatial and mobility challenges. For the analysis, multi-scalar mapping and statistical analysis will be conducted. Fieldwork will also provide insights. The aforementioned spatial demands and underlying systems (biodiversity, leisure, energy production, movement…) will be also analysed through this.

Outcomes: Analysis results in the forms of maps, graphs, systemic sections, and diagrams.

2-2: Travel pattern analysis

The travel pattern of Limburg in the Euregio context will be conducted both quantitatively and qualitatively. On the Quantitative side, location-based accessibility analysis will be conducted using an existing open-source toolkit, and public transport and cycling accessibility analysis using General Transit Feed Specification (GTFS) data will be used (This will be also used in the testing phase.). A macroscopic traffic model will be also created on the scale of Euregio Meuse-Rhein, which will provide further estimates of the bigger travel patterns.

On the qualitative side, ethnographic research on the immobile groups (groups that lack the capacity to access activities) and their usual movement destinations will be conducted to incorporate the local knowledge that is not measured in the quantitative analysis. Based on the current results of the demographics analysis, the hypothesis for the 3 groups to be focused on and the typical family model is decided.

- Countryside, group 25-50, unemployed, no access to cars, household size 3+
- Countryside, group 25-50, employed cross-border, no access to cars, household size 2+
- Woonkern with lower income, group 50+, employed inside municipality or unemployed, no access to cars, single-person household
- The "normal family" model: Countryside, group 15-25 and group 25-50, employed, access to 2+ cars, household size 3+

Outcomes: Analysis results in the forms of maps, drawings, transcripts/materials, and O/D matrix.

**3: Multi-criteria analysis**

Based on the outcomes of #1-1, the ideal mix of elements and technologies of the BRT system will be decided through a multi-criteria analysis. The resulting technology mix, and its spatial requirements and impacts, will lay the premise of the design exercise.

Outcomes: Selected technology/element mix alternative and its spatial requirements and impacts.

**4: Vision: Spatial framework**

Based on the results of #2 and #3, the new relationship and network between cities in Euregio Meuse-Rhein will be provided as a vision. The results of #2-2 and VITO Nodality and Amenities data will be also used to determine types of areas, such as (as a hypothesis) the areas to be prepared for shrinkage (Low Nodality, Low Accessibility, Low Amenities), to be strengthened (High Nodality, High Accessibility, High Amenities), to be focused on providing transport services (Low Nodality, Low Accessibility, High Amenities), and to be focused on improving mixes of functions (High Accessibility, Low Amenities).

Outcomes: Maps in the Euregio Meuse-Rhein scale depicting the new spatial vision based on the new connectivity. Typology of future intervention based on #2-2 and VITO Nodality and Amenities data.

**5: Design toolbox**

The design exercise will aim to create two design toolboxes: One for designing transport nodes, corridors, and their spatial integration, and the other for planning the public transport service in the future.

The first toolbox will be utilising the pattern language as a communication tool for participation. The patterns will represent the aforementioned spatial demands (biodiversity, leisure, energy production, and movement…). The impact of the second toolbox will be also connected to the first toolbox, so that the positive impacts of transport service provision can be used as leverage in realisation.

The second toolbox will provide a catalogue of the destinations (meaning neighbourhoods available to be served by public transport in this context). The destinations will be classified into multiple types, based on parameters including: the amount of amenities/activities, socioeconomic situation, level of accessibility, Belfius municipal classification, and VITO Nodality and Amenities data.

Both toolboxes will estimate their impacts on the parameters of the allocation framework, which will be listed in #6.

Outcomes: Design toolbox for spatial intervention (Patterns and allocation framework), design toolbox for service planning (Destination typology and profiles)

**6: Application of patterns and designs + testing**

In this phase, based on the results of #1 (evaluation criteria) #4 and #5, the actual Design exercise on selected locations will be conducted by applying the patterns of #5. Based on the typologies analysed in #2, #4, and #5, several example locations for detailed design in varying scales will be decided.

The patterns will be applied according to the "allocation framework", which guides the allocation of spatial demands by synthesising diverse parameters in neighbourhood or hectare level of detail, including:

- Accessibility
- Transport performance

- Walkability
- Walkabilitytool: Street connectivity per ha
- Walkabilitytool: Walkability per ha
- Walkabilitytool: Housing density per ha
- Walkabilitytool: Mix of functions per ha
- Mobi-score per ha
- VITO amenities and nodality data per ha
- Heat Stress per ha
- Natura 2000 / VEN
- Sewage system
- Flood risk
- Number of residents and jobs per ha
- Core, Ribbon, Dispersed building typology per ha
- Public transport & cycling accessibility from #4
- Neighbourhood level (statistical sectors) socioeconomic parameters (age, income…)
- Neighbourhood level average number of cars
- Neighbourhood level population ageing trend, between 2011 to 2019
- Surrounding nature
- Surrounding land use, in percentage

The parameters in the allocation framework will be weighted per 3 different perspectives: Liveability focus, Environment focus, and Accessibility focus. Each perspective will result in its own mix of patterns of the specific sites, and their application will be assessed based on the evaluation criteria. The most preferable option will result in a detailed urban plan, as a preferred scenario.

Outcomes: Selected locations, Allocation framework, Draft application of patterns, Detailed plan of preferred scenario on selected locations

**7: Operationalising the project**

Based on the principles derived from #1, the plan for facilitating public participation and active creation of knowledge in the process will be specified. This includes the re-arrangement of the stakeholder roles and capacities defined at #1-1, the strategy on facilitating whom to also include and empower in the process, in which setting to be used in the process (current hypothesis is to use #4 and #5 as a means of capacity building, and the preferred scenario and its plans of #6 as suggested outcome). The long-term timeline of impacts, scenarios, and possible future adjustments will be also created.

Outcomes: Timelines, Operational framework

**Literature and general practical preference**

*Since the goal of this section is not indexing but to introduce important literatures in the project, thus the literatures in each section is not sorted alphabetically; they are sorted by (my subjective perception of) importance in the project.*

**Flemish Nevelstad**


- De Meulder, B., Schreurs, J., Cock, A., & Notteboom, B. (1999). Sleutelen aan het Belgische stadslandschap / Patching up the Belgian urban landscape. Oase: Journal for Architecture, 52 (1999).
- Vermeulen, P. (2002). Platteland in de Nevelstad. OASE, 60, 103–107.


**Possible interpretation / future perspective of Flemish Nevelstad**


- Aravot, I. (2004). Netzstadt – Designing the Urban. URBAN DESIGN International, 9(2), 97–97. https://doi.org/10.1057/palgrave.udi.9000117
- Batten, D. F. (1995). Network Cities: Creative Urban Agglomerations for the 21st Century. Urban Studies, 32(2), 313–327. https://doi.org/10.1080/00420989550013103
- Marin, J. (2019). Circular Economy Transition in Flanders. An Urban Landscape Design Contribution. Transitie naar circulaire economie in Vlaanderen. Een Urban Landscape Design bijdrage. [PhD-proefschrift]. KU Leuven.


**Public transportation in the Flemish countryside**


- Smets, M., Blondia, M., De Deyn, E., Ryckewaert, M., Van Acker, M., Wets, G., Creemers, L., Nulens, R., Roox, D., Bellemans, T., Janssens, D., Macharis, C., De Witte, A., Hollevoet, J., Bulckaen, J., Lefrancois, D., Van Reeth, J., Rubiano, N. B., Dujardin, J., . . . Lopez, M. T. (2014). ORDERin'F: Wetenschappelijk verslag.


**Shrinkage**


- Blanco, H., Alberti, M., Olshansky, R., Chang, S., Wheeler, S. M., Randolph, J., London, J. B., Hollander, J. B., Pallagst, K. M., Schwarz, T., Popper, F. J., Parnell, S., Pieterse, E., & Watson, V. (2009). Shaken, shrinking, hot, impoverished and informal: Emerging research agendas in planning. Progress in Planning, 72(4), 195–250. https://doi.org/10.1016/j.progress.2009.09.001


**Spartacusplan**


- De Lijn Limburg. (2004). SPARTACUS PLAN CONCEPT REGIONET LIMBURG.


**Vehicle Automation**


- Snelder, M., de Almeida Correia, G. H., & van Arem, B. (2022). Automated driving on the path to enlightenment? In Innovations in Transport: Success, Failure and Societal Impacts. Edward Elgar Publishing.

- Lutin, J. (2018). Not If, but When: Autonomous Driving and the Future of Transit. Journal of Public Transportation, 21(1), 92–103. https://doi.org/10.5038/2375-0901.21.1.10
- SAE International. (2021). Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles.

**On mobility**

- Cresswell, T. (2021). 온 더 무브(모빌리티인문학 총서 30) (최영석, Trans.). 앨피.

**Accessibility**

- Geurs, K. T., & van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. Journal of Transport Geography, 12(2), 127–140. https://doi.org/10.1016/j.jtrangeo.2003.10.005
- Handy, S. L., & Niemeier, D. A. (1997). Measuring Accessibility: An Exploration of Issues and Alternatives. Environment and Planning A: Economy and Space, 29(7), 1175–1194. https://doi.org/10.1068/a291175
- Hansen, W. G. (1959). How Accessibility Shapes Land Use. Journal of the American Institute of Planners, 25(2), 73–76. https://doi.org/10.1080/01944365908978307

**Mobility Justice**

- Sheller, M. (2018). Mobility Justice: The Politics of Movement in an Age of Extremes. Verso.
- Pereira, R. H. M., Schwanen, T., & Banister, D. (2016). Distributive justice and equity in transportation. Transport Reviews, 37(2), 170–191. https://doi.org/10.1080/01441647.2016.1257660

**Transportation planning**

- Martens, K. (2016). Transport Justice: Designing fair transportation systems (1st ed.). Taylor & Francis.
- McLeod, S., Scheurer, J., & Curtis, C. (2017). Urban Public Transport. Journal of Planning Literature, 32(3), 223–239. https://doi.org/10.1177/0885412217693570
- Stewart, A. F. (2017). Advancing accessibility : public transport and urban space [Thesis: Ph. D. in Transportation]. Massachusetts Institute of Technology.

**Interdisciplinarity in transportation and urban planning**

- Vigar, G. (2017). The four knowledges of transport planning: Enacting a more communicative, trans-disciplinary policy and decision-making. Transport Policy, 58, 39–45. https://doi.org/10.1016/j.tranpol.2017.04.013

**Transportation systems / BRT**

- van Wee, B., Annema, J. A., & Banister, D. (2013). The Transport System and Transport Policy: An Introduction. Edward Elgar Publishing.

- Rodrigue, J. P. (2020). The Geography of Transport Systems. Routledge.
- Currie, G. (2005). The Demand Performance of Bus Rapid Transit. Journal of Public Transportation, 8(1), 41–55. https://doi.org/10.5038/2375-0901.8.1.3


**Infrastructure as public space**


- Shannon, K., & Smets, M. (2016). The Landscape of Contemporary Infrastructure. Macmillan Publishers.


**Co-creation**


- Brandsen, T., Steen, T., & Verschuere, B. (2020). Co-Production and Co-Creation: Engaging Citizens in Public Services. Taylor & Francis.
- Pappers, J., Keserü, I., & Macharis, C. (2020). Co-creation or Public Participation 2.0? An Assessment of Co-creation in Transport and Mobility Research. Towards User-Centric Transport in Europe 2, 3–15. https://doi.org/10.1007/978-3-030-38028-1_1
- Voorberg, W. H., Bekkers, V. J. J. M., & Tummers, L. G. (2014). A Systematic Review of Co-Creation and Co-Production: Embarking on the social innovation journey. Public Management Review, 17(9), 1333–1357. https://doi.org/10.1080/14719037.2014.930505


## Reflection

The topic is well aligned with the studio's themes: The project has a strong interdisciplinary character, and (albeit taking a more sceptical viewpoint) technological innovation is the key topic. It concerns the future impacts of the technology, involving stakeholders, and designing a multi-functional (infrastructural) public space. In terms of the relationship with the track (Urbanism), although it has been difficult finding a balance between the two disciplines due to the project's interdisciplinary character, the urban design remains the core of the project and the primary outcome of the project. Applying the methods of urban design (Pattern language, Maximisation method) in the context of an urban infrastructure project, can bridge the gap in the methods and tools between the two fields and further facilitate disciplinary integration. Lastly, by integrating the qualities of the built environment with the functional aspects of transportation infrastructure, the project offers the possibility of an integrated approach in the architectural practices as well.

**Relevance of the project**

In the scientific aspect, amidst the recent disillusionment of autonomous vehicles, a re-adjustment of the scenarios research based on the achievable level of application in the near future is necessary. The impact of fully automated private vehicles has been well-addressed, but the spatial impact of automated public transportation in a controlled environment has not been adequately addressed.

The project can also contribute to the research on the sprawling areas in the European context, and how public transportation and vehicle automation can play a role in its transition.

From the social perspective, the project can provide a model of providing public transport that is just, sustainable, and better suited for dispersed settlement patterns. This means that the application is not limited to Belgian Limburg, but can be also applied in other dispersed regions in Flanders and Western Europe in general.

Finally, the professional field of urban planning and transportation planning, despite being highly interrelated fields, often differ in their goals and tools. The need for better integration of both in facing the climate crisis has arisen in recent years. By integrating both fields' goals and tools in the project, this project can propose a process that can better integrate the two.