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in between Landscape Design and Engineering**

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DOI

[10.23919/AEITAUTOMOTIVE58986.2023.10217253](https://doi.org/10.23919/AEITAUTOMOTIVE58986.2023.10217253)

Publication date

2023

Document Version

Final published version

Published in

Proceedings 2023 AEIT International Conference on Electrical and Electronic Technologies for Automotive, AEIT AUTOMOTIVE 2023

Citation (APA)

Sapone, S. A., Longo, M., De Wit, S., & Zaninelli, D. (2023). Operations on Railyard Sites, the Dutch Case: in between Landscape Design and Engineering. In *Proceedings 2023 AEIT International Conference on Electrical and Electronic Technologies for Automotive, AEIT AUTOMOTIVE 2023 IEEE*. <https://doi.org/10.23919/AEITAUTOMOTIVE58986.2023.10217253>

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Operations on Railyard Sites, the Dutch Case: in between Landscape Design and Engineering

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Abstract—The technical landscape of railyard sites brings together a multidisciplinary set of expertise and needs. It entails the union of engineering and landscape design concerns, to redefine these spaces in the way they are maintained and potentially transformed. The paper gives an overview of this interplay, focusing on the Dutch panorama to describe experimental procedures to manage and leverage railyards' green spaces in their transformation. It is presented a specific case study, the design for Amsterdam PHS, where technological advancement allowed to redefine the railyard section, providing a new urban park for the city. Ultimately is explored the potentialities and impact of translating this approach in another territorial context, the Italian one, where abandonment phenomena are widespread. The originality of the contribution lies in correlating aspects usually disconnected, such as technical needs, design, and ecological thinking, to propose an alternative management and redevelopment outlook.

Keywords—*Railyard, Technology, Landscape Design, Maintenance, Optimization, Public Green Space*

I. INTRODUCTION

The railway network constitutes a pervasive grid throughout all Europe, connecting a broader territorial system whilst creating disconnections within the city structure. Technological advancements are improving the efficiency of the grid or introducing alternative routes that often make in the infrastructure redundant and subject to underuse phenomena or complete abandonment [1]. This condition, although problematic, also constitutes a realm of potentialities, a constellation of empty spaces primarily within densely built cities. Those become spaces for natural reclamation, with the development of unique and diverse habitats within the urban context.

The preservation of the nature that reclaims these spaces can thus have advantages in terms of biodiversity but also aesthetics and in reducing pollution phenomena (mostly related to soil, water, and sound). Moreover, the efficiency of the network may free up space for the creation of new public spaces in densely built context. The following explores the Dutch experiences in this sense, showcasing an alternative attitude towards urban nature and the appropriation of railyard surface for public uses, as potential best practices to consider in another territorial context. The article provides an overview of the Dutch case in order to describe experimental procedures for managing and exploiting railyard green spaces in their transformation. A specific case study is presented where technological advancement made it possible to redefine the railyard section, providing a new urban park for the city. The

originality of the contribution lies in relating aspects, such as technical requirements, design, and ecological thinking, to propose an alternative perspective of management and redevelopment, where engineering and architecture collaborate.

II. THE VALUE OF RAILWAYS' BIODIVERSITY WITHIN CITIES

Several studies have stressed the importance of railway networks as conduits of biodiversity within territories and as vital biodiversity hotspots within cities [2]. Specifically, crucial conclusions in this sense were possible thanks to the ecological surveys carried out by the school of ecology in Berlin by H. Sukopp and I. Kowarik, [3][4] who also focused on railyard leftover sites. What is paramount in their observation is the realization for the first time of the importance of urban nature for biodiversity, historically regarded as a weed problem to be eradicated [5]. They proved that this type of place, due to the technical nature of the land conformation, its openness and nutrient poor-soil hosts plants and animals that don't find any other habitats within our cities [6].

However, today's common practice in managing these sites tends to eradicate it to ensure the system's operation and follow established management procedures. Considering the foreseen significant population growth in urban contexts in the near future, [7] the inclusion of underused or abandoned spaces will become even more appealing to satisfy future needs linked to the accessibility of green spaces within cities. These site types often spontaneously see the progression of natural reclamation, creating informal green spaces.

This phenomenon, if leveraged correctly, can provide a cost-effective creation of green spaces. This could potentially help to achieve fair access to green spaces within cities, fulfilling European guidelines to increase spatial justice. Specifically, it would address the SDG 11.7, Sustainable Development Goal, devoted to providing access to safe and inclusive green and public spaces. Moreover, these sites see the creation of reach biodiverse habitats, that, if preserved correctly, through sensitive management and transformation procedure, could address the goals of biodiversity preservation set by the EU (SDG, New European Bauhaus, Aichi Biodiversity Target etc.) [8]. Finally, conserving these green surfaces can also provide valuable ecosystem services, like CO₂ absorption, mitigation of the heat island effect, and phytoremediation of the polluted soils [9]

III. THE DUTCH CASE STUDY

Considering the described frame, with an overall increasing need for green biodiverse spaces within cities, (see Fig.1, it is deemed relevant to rethink how we handle railyards, both in the maintenance and transformation of their underused spaces. A relevant case to be described is the Dutch context, ground for forerunner experimentations of alternative practices in managing and monitoring green spaces, both within cities and along the rails. The goal is to display the possibilities of ensuring the optimization of operations and biodiversity [10] whilst revaluating the standard praxis concerning these spaces [11] and driving an alternative design process. In this sense, there is a potential role for designers and engineers as central figures in managing this shift, both as coordinators and implementors of this awareness in the transformation of these sites [6].

A. Alternative management techniques to foster biodiversity

Overall, the Netherlands are experimenting with alternative maintenance techniques to ensure the preservation and creation of biodiversity within the city at different scale. For instance, in the city of Rotterdam, several initiatives exist in this sense [6]. With the project Flora for Fauna, the city is fostering the creation of biodiverse spaces in several locations to host both plants and animals, working on community engagement to ensure maintenance instead of a centralized management system. They are also testing different green management techniques, using grazers in more natural context (like in the Oostvaardersplassen) or rotational techniques, like mosaic mowing, to preserve the species that occur spontaneously and enhance biodiversity, monitoring through biodiversity indicators.

ProRail, the company managing railyard's green (specifically with its devoted branch Spoorbeeld), is also experimenting in this frame. They conducted several ecological surveys of the whole network [11][12][13][14] to map and recognize the diverse landscape occurring along the tracks, defining the existing habitats to be preserved both for ecologic and aesthetic value, constituting unique visual landscape in the Dutch territory. However, due to the extension of the network and the use of external contractors for maintenance, the usual procedure is to eradicate indiscriminately all the vegetation along the track every five years. The railway managing entities are therefore experimenting with limiting the use of pesticides and complete eradication of spontaneous nature, preferring instead rotation techniques to manage the green spaces on railway sidings and railyards, which allow flora and fauna to be preserved [11] [15].



Fig. 1. Picture of a flowerbed in Amsterdam, inhabited by spontaneous nature. Photo by the Author.

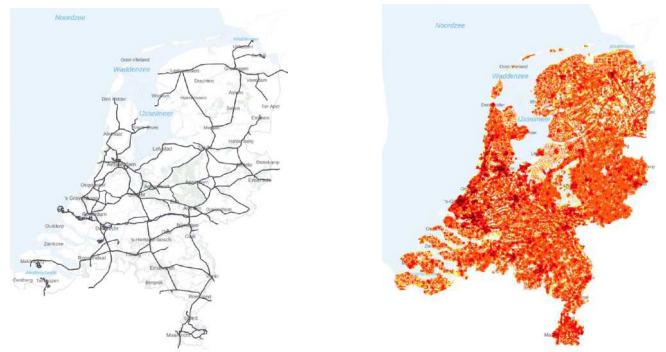


Fig. 2. Maps showing the Dutch railway network (left) and population density (right). Data available on <https://app.pdok.nlz/viewer>

There are also some ongoing experiments to test alternative monitoring of the infrastructure, using Lidar scans to evaluate which species are harmful to the operations and which ones are allowed to stay for their ecological and aesthetic value. Using Lidar scanners to map the vegetation developed along the rails, the goal was to identify obstacles and species to preserve.

B. Optimization of the railway network: availability of new public space

The Hoogfrequent Spoorvervoer program (High-Frequency Rail Transport Programme) in the Netherlands aims to improve the railway infrastructure as shown in Fig. 2 to optimize the journey's speed and at the same time their quality for the passengers. To do so, they studied how to make the operation of the trains more efficient, as well as the possibility of creating pleasant visual landscapes for the train users [13].

At the same time, achieving this efficiency goal of freeing space potentially usable for citizens in dense urban contexts, Fig. 2 creates an opportunity for the project Amsterdam PHS (with the acronym recalling the overall network improvement mentioned above, the Programma Hoogfrequent Spoorvervoer).

IV. FROM RAILYARD TO URBAN PARK: AMSTERDAM PHS

The project is an ongoing design for a (temporary) urban park on a railyard close to Amsterdam's central station as shown in Fig. 3. It aims to answer the question: "How can you give more space to Nature in a dense city like Amsterdam? [16] (see Fig. 4).



Fig. 3. Aerial image of the Amsterdam PHS site, Desaturated image modified by the Author. Original available on <https://app.pdok.nlz/viewer>



Fig. 4. Infrared aerial photo of the site, helpful to show the vegetated surfaces. The latter are mainly in red, since chlorophyll reflects strongly the infrared rays. Original available on <https://app.pdok.nlz/viewer>



Fig. 5. Reconfiguration of the railyard tracks. Images redrawn by the author according to the masterplan of Movares available in [16] and on <https://www.prorail.nl/projecten/aanpassingen-station-amsterdam-centraal>

This design questions the current maintenance practice, advocating for the increase of biodiversity and public spaces within the city. Moreover, the location was seen as an ideal steppingstone for ecological biodiversity. This project is relevant as an instance of a potential frequent condition, the one of available urban spaces along working tracks as new design challenge.

A. The technical innovations that made it possible

The occasion for which this space became available to be transformed is linked to the optimization of the Dutch railway system, the Hoogfrequentspoor program. Some rail tracks in a railyard close to Amsterdam's central station were made redundant, freeing space potentially usable for citizens as shown in Fig. 5 and Fig. 6. It is an instance of how technological advancement and network management can imply more space for the city, presenting new design opportunities. However, in a city as densely built as

Amsterdam and with the current housing crisis, the risk of transformation into another residential neighborhood was quite likely.

Nevertheless, the municipality wanted to increase the availability of green spaces around the city, enforcing the green corridor established by the infrastructure and defining this place as a "green gate" for the city. So, the landscape designers and engineers from Movares (an engineering and landscape consultancy company based in the Netherlands) were contracted to address these needs, mindful of rail operations necessities.

B. The design invention and solutions

The project questions the boundaries between the railyard enclosure and the city, pushing the wall as far as possible to grant access to the site as an urban park, with different potential scenarios to show how the species' usage may shift (Fig. 8). The main principle was to reappropriate the space of the track for public use, creating a temporary urban park. Temporary because the ownership is retained by the railway company but with a deadline not fixed, dependent only on the future needs of the network. In this way, citizens can enjoy the extra green space in a densely build city like Amsterdam as shown in Figg. 4 and 7.

The project also questions the traditional role of the fence, Fig. 8 pushing as much as possible its position in favor of the space accessible to visitors, always ensuring their safety from the operating trains as well. To establish a connection or discourage accessibility in unsafe spots, it plays with the height of the railway relief, using gabions filled with pebbles either as walls or contour lines in this topography. The pebble-size choice also allows them to host bird's nests and the development of spontaneous vegetation. Notably, these elements constitute, together with the vegetation, the unifying trait of the different interventions along the line, recalling gabions already existing in the project's vicinity and along the tracks. Also, the plant design is sensitive to the need of the network, accounting for the need for visibility and operability of the trains whilst creating a shaded space for public functions. For the material's choice, the principle is to operate as much as possible through the reuse of materials present on-site or in the vicinity, integrating them into the urban furniture design thought for the park (e.g., Benches inspired by the rails retaining wall). To clarify these choices in the project implementation, the designers created a "book of references" for the contractors, making explicit rules in terms of outsourcing and choice of material, especially for repurposed ones.



Fig. 6. Reconfiguration of the railyard tracks, comparison between the past and the vision for the site's future. Images courtesy of Prorail. Available on <https://www.prorail.nl/projecten/aanpassingen-station-amsterdam-centraal>



Fig. 7. Zoom on the future park area. Aerial view from 2020 and today, during the construction stage. Desaturated image, Original available on <https://app.pdok.nl/viewer>



Fig. 8. Forseen Design for the main park area. Image courtesy of Movares and Prorail. Available in [16] and on <https://www.prorail.nl/projecten/aanpassingen-station-amsterdam-centraal>

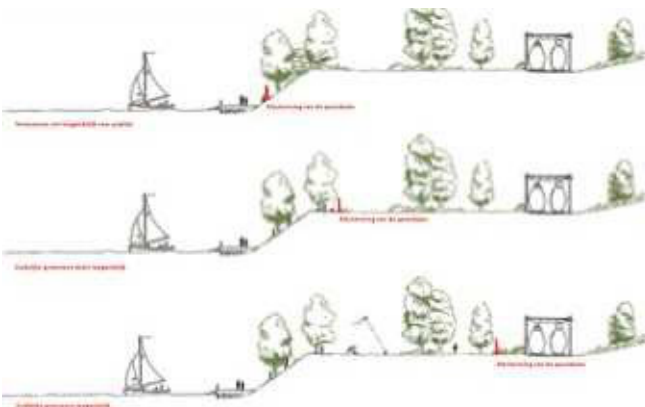


Fig. 9. Scheme of the change in section introduced by the design, with different possible wall positions (in red). Images courtesy of Movares and Prorail. Available in [16] and on <https://www.prorail.nl/projecten/aanpassingen-station-amsterdam-centraal>

C. Management implications

The park area will still belong to the railway company, which wants to keep the right to reinstate the tracks if needed, but its maintenance is managed by the city of Amsterdam as one of their public spaces. Also, the current maintenance practice of the tracks is rediscussed. Currently, every five years the railway maintenance team destroys all the vegetation along the tracks. In this case, new plants and trees will be planted, choosing species that cope with working rails and the soil character. Between the tracks there will be more resistant and wild-like plants, whereas in the accessible area ornamental grasses and trees will be planted.

The goal is to have native species, able to provide an interesting landscape throughout the season, with drought tolerance and that avoid blocking the view for trains, able at the same time to attract local fauna, in particular birds. Birches were chosen as the main essence to be used, as a robust, not too dense, or tall, and easy-to-maintain plant. Different species of shrubs, in particular bramble and gorse, were selected instead to create a variable scenery perception and attract local birds. Ultimately, as stated by the designer, their attention to the ease of maintenance was what made it possible to advocate for the park's realization and its acceptance by the railway managing company.

V. TAKEAWAY FROM THE AMSTERDAM PHS PROJECT

Overall, the Amsterdam case shows how a neglected and underused space, a burden to maintain for the railway company, can become instead a space for the community, fostering social and environmental well-being. An interesting aspect of this design is also its multidisciplinary perspective. Involving engineers, landscape architects and architects it's created a link between technical needs, social and environmental concerns. The designers tested a new spatial solution and its effects on society, verifying the social acceptance through citizens workshop and discussion with stakeholders, and environmental benefits, correlating the site with a broader ecological system interesting the city and the rail network.

Moreover, the creation of additional green spaces on a former mineral surface will aid in reducing the heat island effect in the urban context, whilst increasing CO₂ capture or the area thanks to the added plants. In addition to this, certain design choices, stated in the book of references, such as the reuse of industrial steel plates for the retaining wall or existing pebbles present on site, strengthen the circularity of the project, making it also more economically viable. In this sense, also the choice of questioning established maintenance practices ultimately made them potentially cheaper, avoiding the unnecessary continuous mowing of the grounds and allowing a designed set of species to stay.

The project also creates a precious asset for a densely built city, an accessible green space that adds value for the surrounding community in terms of life quality but possibly also in the housing value.

And what's relevant is also the creation of two different ways of experiencing the space: the one from within the park, by the citizens, and the one from the train by the commuters. An example in this sense could be discussed on the Italian one, opening a theoretical reflection on the possible implication of such outlook on this type of site. Introducing in this context similar solutions in terms of design and maintenance,

translated to the needs of Italian railway network, could have a significant effect considering its widespread phenomena of underused space throughout the whole system. Several studies have stressed the importance of the railway network as a conduit of biodiversity within territories and a vital biodiversity hotspot within cities, even in the Italian context [17-19].

VI. CONCLUSIONS

The potential impact of this paper is to foster a similar discourse in other territorial contexts. Its significance resides in correlating a multidisciplinary set of concerns, usually disconnected, such as technical needs, spatial design, and ecological thinking in relation to an infrastructural landscape.

Historically cities have pushed more and more green areas outside their border. However, the exponential population growth within their border and the proven ecosystem service they provide are calling for their need in urban contexts. In this frame, railway-underused spaces may help to fulfil this need, also creating an enlargement in the green ecological corridor created by railway's embankments. Learning about the cited experiments in this sense can stress the importance of this sensitivity even for our territorial context, much more diverse and extended than the Dutch ones, to rethink the way we manage and transform this infrastructure, and to valorize the unique visual landscape that the rail infrastructure provides. At the same time, stressing the potential opportunity presented by these underused rail spaces in the major Italian cities is a central design question for the future of this contexts, as proven by the competition experience of the Sette Scali di Milano, an ongoing experimentation in this sense. These types of areas can provide much-needed green spaces for densely built urban contexts, which are already developing on their own through natural reclamation only lacks public access. The advantage is then both for the railway companies, which can cut maintenance costs on spaces they no longer need, and for cities that gain extra space for their citizens.

Overall, the end goal of the paper is to offer a different perspective on the way we manage the railway infrastructure and its transformation, both from the technical and aesthetic point of view, with a multidisciplinary outlook on the topic.

ACKNOWLEDGEMENT

This paper was developed in the frame of the PhD research of Sara Anna Sapone *Precision Wildland. Designing Third Landscape within the Smart City, A Focus on Railyard Marginalia*. The research is carried out within the AUID program at Politecnico di Milano, under the supervision of Prof. Sara Protasoni, Emilia Corradi and Michela Longo. It was also developed through a six months exchange at the

Landscape Architecture section of TU Delft, with the supervision of Saskia de Wit.

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