

On the Brillouin Zones of Glide-Symmetric Structures

Original

On the Brillouin Zones of Glide-Symmetric Structures / Petek, Martin; Alberto Tobón Vásquez, Jorge; Valerio, Guido; Mesa, Francisco; Quevedo-Teruel, Oscar; Vipiana, Francesca. - In: IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. - ISSN 0018-926X. - 74:2(2026), pp. 1601-1614. [10.1109/tap.2025.3640356]

Availability:

This version is available at: 11583/3009271 since: 2026-03-27T08:03:26Z

Publisher:

IEEE

Published

DOI:10.1109/tap.2025.3640356

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

PUBLIC SPACES FOR COMMUNITY CAMPUSES AND UNIVERSITIES

Edited by
Marichela Sepe



INU Edizioni

Accademia
Collana diretta da
Francesco Domenico Moccia

Comitato scientifico:

Giuseppe De Luca, Università di Firenze

Paolo La Greca, Università di Catania

Brian Muller, University of Colorado Boulder

Marichela Sepe, Sapienza Università di Roma

Loris Servillo, Università di Lovanio

Silvia Viviani, INU

Athena Yiannakou, Aristotle University of Thessaloniki

Yodan Rofe, Università Ben Gurion di Negev

Oriol Nel·lo, Universidad Autónoma de Barcelona

Alessandro Sgobbo, Università Federico II

I volumi pubblicati in questa collana sono
preventivamente sottoposti ad una doppia procedura di 'peer review'

Progetto grafico
Ilaria Giatti

Prodotto da
INU Edizioni Srl
Via Castro Dei Volsci 14
00179 Roma
Tel. 06 68134341 / 335-5487645
inued@inuedizioni.it
www.inuedizioni.com
Iscrizione CCIAA 81 4890/95
Iscrizione al Tribunale di Roma 3563/95

Copyright
INU Edizioni Srl
È possibile riprodurre testi o immagini con espressa citazione della fonte

Finito di stampare
Luglio 2025
Officine Grafiche Francesco Giannini & Figli SpA

In copertina
Copenhagen: detail of the Søndre Campus (photo by Marichela Sepe)

ISBN: 978-88-7603-269-1 (e-Book) €. 0,00
Open access <http://www.inuedizioni.com>

A campus in a park. The Architecture Campus of Politecnico di Torino

*Carlo Deregibus**,
*Matteo Tempestini***
*Antonio De Rossi****

Politecnico di Torino and its role within the city

The Politecnico di Torino is experiencing significant growth, characterised by an increasing involvement with the local community and the city, a continuous growth in the number of students, and a push towards internationalisation. In this context, space is paramount in broadening course offerings and intensifying collaboration with industrial partners. This problem cannot be regarded as purely a planning issue; the lack of consistency between political intentions and the scheduling of building activities often results in a misalignment of timings, objectives, and language.

The establishment of the Masterplan Team of the Politecnico in 2016 was a strategic response to these coming challenges. The Masterplan is a research group entrusted with translating the university's policies into spatial strategies through continuously developing scenarios and spatial configurations. Given that every policy is materialised in space and necessitates spatial considerations, the Masterplan employs architectur-

* Politecnico di Torino; e-mail: carlo.deregibus@polito.it

** Politecnico di Torino; e-mail: matteo.tempestini@polito.it

*** Politecnico di Torino; e-mail: antonio.derossi@polito.it

al design as a tactical and dialogical instrument, serving as a medium for debate and experimentation with innovative, mission-driven solutions (De Rossi & Deregibus, 2020). This approach enables an inclusive and effective dialogue on spatial and urban issues, clarifying visions and potential conflicts. It also serves as a mediation tool for Politecnico's governance, supporting the implementation and revision of its Strategic Plan. The Masterplan Team also aims to involve and coordinate the university's development projects with external stakeholders, such as the City of Torino, the Metropolitan Community, the Piedmont Region and other economic and social private actors. This process contributes to the enhancement of the urban environment, thereby positioning the Politecnico as a key player in the improvement of Torino's built fabric, reflecting the contemporary role of an institution of higher education within the city, aligning both its demands with those of external stakeholders (den Heijer & Curvelo Magdaniel, 2018).

Therefore, the Masterplan is not merely a strategic or policy document; it functions as a dynamic research facility that perpetually translates policy statements into spatial forms and anticipates future scenarios. The Masterplan Team's approach situates the project within strategic and operational contexts. The effectiveness of this approach is also due to the Team dynamic and minimally hierarchical structure, which ensures tight control over project resources and communication. Through presentations, reports, drawings and visualisations, the Masterplan Team orients stakeholders through project development, promoting understanding and encouraging proactive engagement. The Team is also responsible for managing external factors, including policies and regulations. Furthermore, the Team fosters collaboration to create synergies for projects in shared spaces where multiple interactions occur. Hence, the Masterplan Team plays a pivotal role in the urban development of the Politecnico di Torino, designing its campuses and their integration and participation in urban spaces, contributing to «break[ing] down the conventional boundaries between campus and city» (Hebbert, 2018).

This paper will address one of the main challenges that Politecnico will face shortly: the reorganisation of the architecture, design and planning schools, which are currently spread over several sites within the City. The project aims to create a more centralised campus that establishes a deeper relationship with the city's urban fabric and natural environment.

One university, two campuses, many mission-oriented sites

A key output of the Masterplan Team is an urban plan showing (and simultaneously planning) the atheneum's campuses and site organisation. The plan defines two main hubs: the Engineering Campus and the Architecture one (now called *Campus delle Architetture, del Design e della Pianificazione*, or *Campus for Architecture, Design and Planning Schools*). These two hubs are surrounded by a network of mission-oriented sites that exploit third-mission and research opportunities throughout the City and the region. Within this framework, the ambitious Architecture Campus aims to consolidate all architecture, design, and planning activities and spaces – like teaching facilities, classrooms, departments, offices, research laboratories, and soft spaces – into the Parco del Valentino area along the river Po. Moreover, by enlarging the present spaces with new spaces, there will be a complete reorganisation of all historical sites, possibly defining the two thematic campuses. Hence, due to its indirect effects, the Architecture Campus also has a broader strategic dimension.

In opposition to the Engineering Campus, which, as per the classifications proposed by Van den Berg and Russo (2004), is characterised by a formal relationship with the City, as evidenced by its enclosed perimeter, the Architecture Campus will adopt a more informal approach, situated within a public, rhizomatic, and permeable space. Its boundaries will blend seamlessly into the urban fabric, the Parco del Valentino's natural environment and along the river Po's banks.

Toward the Architecture Campus in the area of Parco del Valentino, Torino

Historically, the Parco del Valentino has a strong cultural and anthropic vocation. Currently, the Parco del Valentino area is home to three locations dedicated to the school of architecture and planning: the historic headquarters of the Castello del Valentino and two smaller branches located on Via Morgari and at the Istituto Galileo Ferraris. In addition, new spaces will include three pavilions from the Torino Esposizioni complex, the latter representing strategic elements of the entire project, essential for developing the new Campus inside the Parco del Valentino. In addition, within the park's perimeters and immediately south of the castle, Politecnico will realise a small pavilion in collaboration with Tongji University of Shanghai (Figure 1).

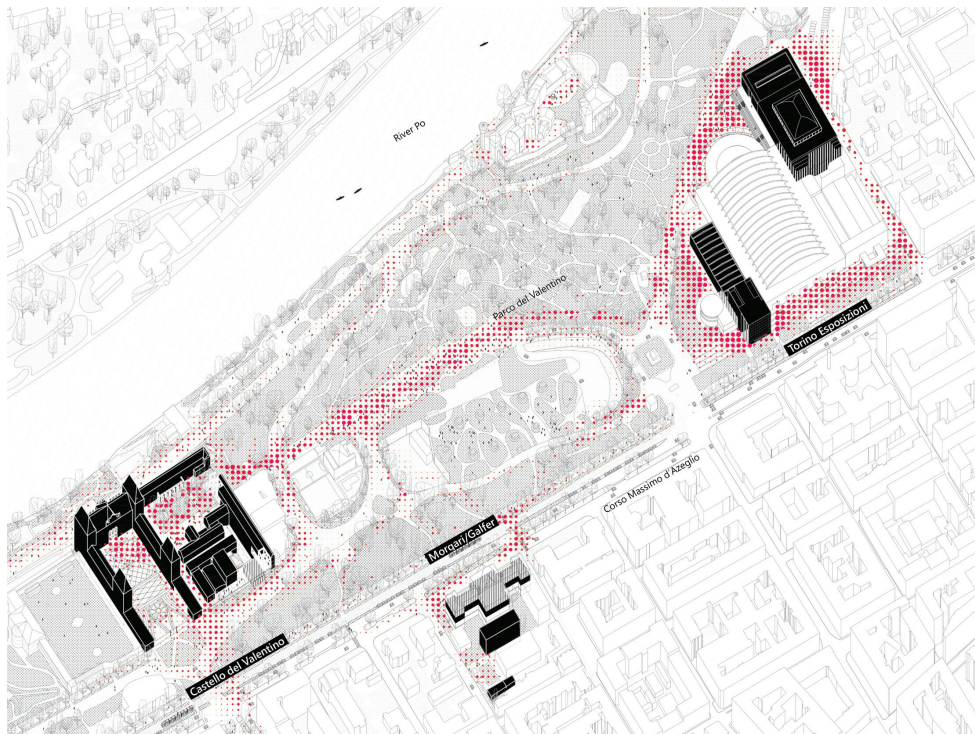


Figure 1 -
The new Campus delle Architetture, del Design e della Pianificazione in the Parco del Valentino, along river Po

The Architecture Campus project has a specific procedural and organisational framework. The university governance has appointed a representative of the rector to oversee the campus development. This representative is responsible for collecting and synthesising the requirements of the two departments involved (DAD – Department of Architecture and Design and DIST – Interuniversity Department of Science, Project, and Territorial Policies). The representative works closely with the Masterplan Team, which, in addition to having authored the Torino Esposizioni project, also acts as a mediator for the needs of external stakeholders such as the Superintendence or the City. This organisational structure satisfies all internal university needs while enhancing the relationship with the other external stakeholders. For instance, the City of Torino plays a key role in this initiative. In fact, leveraging the opportunities afforded by the PNRR funds (National Recovery and Resilience Plan), a comprehensive redevelopment initiative has been initiated for the entire Valentino area. The project encompasses an area of 400,000 square metres and is designed to restore the park's cultural and natural identity. The initiative involves the restoration of the Po River's navigability, establishing a direct connection to the city centre through the river axis. Inside the refurbished

Pavilion 2 of Torino Esposizioni will take place the new Central Civic Library, while the Teatro Nuovo will undergo restoration to its original entertainment purpose. At the same time, a significant redevelopment process will be undertaken at Parco del Valentino. The asphalt surface will be replaced with permeable paving, the riverbanks of the Po will be renovated, and the roof surface of the subterranean pavilion designed by Riccardo Morandi at Torino Esposizioni will be refurbished. All parking spaces will be condensed within Morandi Pavilion, freeing up green areas and routes for vehicular traffic. The complementary interventions carried out by Politecnico will affect the configuration of the entire area, which will become a significant cultural hub of the city. Nevertheless, the presence of a diverse range of functions and activities, extending beyond the boundaries of academia, in conjunction with substantial green spaces and notable natural elements, has been demonstrated to foster not only the well-being of campus users (Siu, Gou & Liu, 2014) but also that of the broader neighbourhood and its diverse demographic (Sepe, 2017).

In any case, the intervention philosophy closely looks at the vocational dimension of the existing places, developing and enhancing their potential (Jullien, 1996).

Vocational purpose of the spaces and enhancement of the campus identity

A short history of Castello and Parco del Valentino and Torino Esposizioni

The Campus will take place in an environment with significant historical, cultural, and natural value. The two main focuses of the Campus will be the Castello del Valentino and the complex of Torino Esposizioni, both renowned for their historical and architectural value. These, in combination with the Parco del Valentino, will contribute to the strong identity of the new Campus.

The Castello del Valentino, owned by the Savoy family since 1564, was transformed into a *Maison de Plaisance* in 1620 by Cristina of France, who commissioned the architects Carlo and Amedeo di Castellamonte. After several morphological changes, the castle ceased to be a royal residence at the beginning of the 19th century. The Royal School of Engineering was inaugurated in Castello Valentino at the beginning of the 1860s, as authorised by the Casati Law of 1859. Concurrently, the Parco del Val-

entino was established in its present form, becoming Torino's most significant monumental park. The park was designed by the gardener and landscape architect Jean-Baptiste Kettmann and has always been used not only as a natural environment linked to the City but also as a highly anthropised space where numerous cultural activities occur. The cultural and academic characterisation of the park can be traced back to the 1880s when the mayor Ernesto Balbo di Sambuy launched a project to create a university campus known as the *Città delle Scienze* (Cardoza & Symcox, 2006). In the meantime, the park has been utilised for several cultural events, including the *Esposizione Generale Italiana* in 1884 and the *Esposizione Internazionale di Torino* in 1911.

The genesis of the Torino Esposizioni complex can be traced back to the cultural ethos of the Parco del Valentino. Situated on a triangular plot of land to the south of the park, the complex's origins date back to 1936, when Ettore Sottsass Sr. won the design competition organised by the City (Pagano, 1936). Sottsass's winning project featured four pavilions surrounding an open green courtyard. The four pavilions – the main hall or Pavilion 1, the exhibition hall, the theatre and the offices – and a fifth circular pavilion called the Rotonda were inaugurated in 1938 but had limited use. In 1943, during the Second World War, the complex was severely damaged by bombing, especially in the southeastern part, including the theatre and the exhibition hall.

After the war, a collective of local industrialists established the *Società del Palazzo delle Esposizioni* to reconstruct the complex to accommodate important trade fairs and promote the emerging local industrial sector (Tralbaut, 1957). The architect Roberto Biscaretti di Ruffia and the engineer Pier Luigi Nervi led the project. In 1947, the exhibition wing, or Pavilion 2, underwent reconstruction. Here, Nervi employed a distinctive technological solution, utilising prefabricated ferrocement elements to cover the impressive barrel vault (Nervi, 1957). The theatre, subsequently renamed Teatro Nuovo, was rebuilt, retaining its original design with one closed and one open proscenium arch. A few years later, in 1950, the open-air theatre was replaced by Pavilion 3, which Nervi also designed. This structure was notable for its use of prefabricated ferrocement elements, a technique previously employed in Pavilion 2, and its design featured a centrally planned structure with a large pavilion roof supported by four reinforced concrete arches (Nervi, 1950). In the sixties, the eagerness for additional exhibition space led to the construction of an underground pavilion designed by engineer Riccardo Morandi, located just north of the Rotonda, towards the Castello del Valentino.

Since the 1980s, the Torino Esposizioni complex has gradually fallen into disuse, except for sporadic sporting and cultural events, and has been completely abandoned in recent years. Over the years, various extensions have been added, including Pavilion 3b in the 1970s, located adjacent to the east of Pavilion 3a. In 2014, the City of Torino developed a preliminary proposal for its restoration in collaboration with the Politecnico, resulting in a feasibility study. Here, the School of Architecture of the Politecnico was relocated to Torino Esposizioni, specifically inside the subterranean pavilion designed by Riccardo Morandi.

The prospect of renovating the pavilion proved unfeasible due to the imminent implementation of stringent structural and seismic regulations in 2018, which mandated extensive modifications, structural adaptations, and consolidations. This challenge was further compounded by the declaration of monumental interests of the pavilions in 2022 and by the constraints imposed by the town plan. Nevertheless, the site remained of paramount importance to the Politecnico, as it represented the sole viable opportunity to establish a comprehensive campus for the School of Architecture, capable of integrating the historic headquarters in the Castello del Valentino and utilising the Parco del Valentino spaces as common areas for all campus users. Finally, in 2020, the Masterplan Team was appointed to develop new proposals for Torino Esposizioni, toward the *Campus delle Architetture, del Design e della Pianificazione*.

The project of Torino Esposizioni

The Masterplan Team devised numerous scenarios to reuse the entire complex, conceptualising alternative and hitherto unexplored options. The analysis of different scenarios allowed a comprehensive assessment of each scenario's pros and cons, ultimately leading to the selection of the most suitable and financially viable solution. Following an evaluation process and a series of political mediations with multiple stakeholders, including the Superintendence, potential co-users, the City of Torino, and the administration and governance of Politecnico, the Team proposed to the City that three pavilions of the complex should be assigned to Politecnico (namely pavilions 1, 3a and 3b).

While formulating the new hypothesis, the Team developed a novel framework to address the diverse needs and requirements of all the future users of the Campus. The analysis evaluated prospective future developments in terms of numbers and facilities, with a particular emphasis on environmental and spatial quality as the central tenet of the design.

External and open spaces were given particular consideration, with the project's development as a series of public and accessible spaces interconnected by green fields, park paths and internal *promenades architecturales*. The teaching spaces were designed to be flexible and comfortable to accommodate a variety of teaching methods, favouring the possibility of hosting experimental and atelier-like activities and laboratory courses. Finally, much attention was paid to the inclusion of soft spaces.

The design actions have exploited the historical dimension of the complex, using sources and documents to ground the modifications and valorising the space consistently with the designers' original intent. New technologies, a respectful attitude, and a bold design approach have been used.

The Sottsass Pavilion (formerly Pavilion 1) has been restored to revive the monumental atrium's expansive spatiality while retaining the marble's original materiality and restoring the large external portico. The upper level features a versatile floor plan accommodating research centres and department offices. The primary structure has been implemented with a newly constructed floor, which facilitates the establishment of two-storey classrooms facing the park.

The Nervi Pavilion (formerly Pavilion 3a) is the most iconic and recognisable space, serving as a genuinely international showcase of intrinsic cultural, architectural and historical significance. Accessible from the Gallery, also designed by Pier Luigi Nervi, which features a continuous longitudinal skylight, the pavilion serves as the new Campus's focal point and main public space. The space's multifaceted nature allows it to function as a workroom for students, an exhibition space, a venue for events, and a construction workshop. Two small glass boxes on the sides of the central hall will allow for various facilities, depending on the needs of the Campus, without compromising the architectural lines of the vault (Figure 2).

The New Pavilion (formerly Pavilion 3b) has a minimalist and hi-tech exterior and retains all the complex's architectural lines, making it the perfect end to the series of buildings. Here, many of the classrooms from across the complex are gathered. It also connects the two sides of the park, following the Gallery's path, and creates a visual axis of over one hundred metres.

Construction began in 2024, whereas completion is scheduled for 2027. After completion, the Torino Esposizioni operation will ensure the operational functioning of the new *Campus for Architecture, Design and Plan-*



ning Schools. The Campus will be a key asset for the City of Torino and, more importantly, provide innovative and inspiring spaces for students and faculty at Politecnico di Torino, reflecting the institution's international scope.

Figure 2 -
The large hall of the Nervi Pavilion will be the core of public life in the Campus

Public spaces in a public campus

The new Campus is set to become a significant international hub. Its unique position within one of the most important public green areas in Torino guarantees seamless integration into a vast public open space of over 400,000 square metres along the Po River's western banks. This expansive public space will serve as a venue for social interaction, well-being, and welfare for all campus users. The architectural significance of the Campus's spaces is further emphasised by their potential to enhance the learning process, mainly through their integration with the external environment and the environmental and naturalistic dimension of Parco del Valentino. Consistently with many international best practices (Bacevice & Dunkle, 2018; Soares, Weitkamp & Yamu, 2020), the Campus aims to provide a vibrant living space that is welcoming to its users and the public. In this sense, removing all the present fences and gates around Torino Esposizioni will enormously increase the permeability of the complex and its relation to the terraced outdoor areas, a feature glorified by the opening of twelve entrances to the three pavilions of Politecnico, compared to the present two.

Then, interlaced with the public spaces, three will be the major public cores of the Campus. The first and most obvious is Pavilion Nervi, with its large

vaulted hall. The pavilion is planned to be entirely open and permeable, functioning as a covered square where citizens can participate in exams, exhibitions, conferences, and workshops. The flexible space can be equipped according to different uses, needs and levels of interaction between the student population, faculty and administrative staff and citizens. Therefore, the hall acts as a key connector to the park, capable of expanding the cultural mission of Politecnico beyond purely academic boundaries. Despite management and access control challenges, the planned operational strategies will ensure that the diverse needs of users and the community are met, adapting to different levels of social interaction.

The second is the atrium of Pavilion Sottsass, whose public role will further support this dynamic engagement, reinforcing the institutional relationships with the public. Designed as a pleasing and welcoming space, the atrium is directly connected with the primary access to the park and the complex of Torino Esposizioni, blurring the lines between the built environment and the natural surroundings.

The third is indeed the Castello del Valentino, whose historical relevance also plays a central role within the Campus, offering several spaces for academic and cultural activities. The spaces within the Castello are key to fostering a deeper connection to the city's cultural heritage while integrating with the modern learning environments. The courtyards and open spaces within the Castello del Valentino add further layers of interaction, creating an environment where the boundary between the Campus and the city is effectively minimised. Hence, a future intervention would aim to eliminate the car parking in the south courtyard and change the space into a soft, permeable space, providing new areas for outdoor events, public art, and informal gathering spots. Envisioned but not yet planned, this intervention would be critical for the entire Campus, as the space is directly connected to the core of the park.

Furthermore, the integration of these spaces will be characterised by a cohesive network of connections throughout the Campus, with the relationship to the Central Civic Library being pivotal in ensuring that students, faculty, and the public can seamlessly access knowledge and culture. The open spaces will encourage collaboration, relaxation, and social interactions, as well as the connections between the buildings, the library, and outdoor spaces, fostering a sense of community and offering a rich and dynamic environment that encourages academic and social engagement. Integrating the two focal points, Castello del Valentino and Torino Esposizioni will activate the intermediate spaces of the Parco del

Valentino, creating a fertile ground for cultural and social exchange between the city and the Politecnico communities. Implementing the *Campus for Architecture, Design and Planning Schools* will foster a symbiotic, sustainable, and mutually reinforcing relationship between the university and the city.

References

- *Bacevice, P., Dunkle, B. (2018) Creating a Sense of Community on Urban College and University Campuses. Implications for Planning and Design, Planning for Higher Education Journal, (47)1.*
- *Cardoza, A. L., Symcox, G. W. (2006) Storia di Torino. Einaudi, Torino.*
- *De Rossi, A., Deregibus, C. (2020) Form as strategy, project as tactics, in: De Rossi, A. et al. (eds) Spatializing Strategies. The Masterplan of Politecnico di Torino 2016-2020. Siracusa, LetteraVentidue, pp. 95–101.*
- *Den Heijer, A.C., Curvelo Magdaniel, F.T.J. (2018) Campus-City Relations: Past, Present, and Future, in Meusbürger, P., Heffernan, M., Suarsana, L. (eds) Geographies of the University. Knowledge and Space, vol 12. Cham, Springer, pp. 439-459.*
- *Hebbert, M. (2018), The campus and the city: a design revolution explained, Journal of Urban Design, (23)6, pp. 883-897.*
- *Jullien, F. (1996) Traité de l'efficacité. Paris, Grasset & Fasquelle.*
- *Nervi, P. L. (1950) La struttura portante del nuovo Salone del Palazzo di Torino Esposizioni, Atti e Rassegna Tecnica della Società degli Ingegneri e Architetti in Torino, 8, pp. 5-7.*
- *Nervi, P. L. (1957) Pier Luigi Nervi. Edizioni di Comunità, Milano.*
- *Pagano, G. (1936) Il Palazzo della Moda, a Torino, Casabella, 108, pp. 20-25.*
- *Sepe, M. (2017) The Role of Public Space to Achieve Urban Happiness, International Journal of Sustainable Development and Planning, (12)4, pp. 724-733.*
- *Siu, Y.L.S., Gou, Z., Liu, Y. (2014) Healthy campus by open space design: Approaches and guidelines, Frontiers of Architectural Research, 3, pp. 452-467.*

- *Soares, I., Weitkamp, G., Yamu, C. (2020) Public Spaces as Knowledge-scapes: Understanding the Relationship between the Built Environment and Creative Encounters at Dutch University Campuses and Science Parks, International Journal of Environmental Research and Public Health, 17.*
- *Tralbaut, M. E. (1957) Torino Esposizioni. Dieci Anni 1947-1957. Lorenzo Rattero, Torino.*
- *Van den Berg, L., Russo, A. (2004) The Student City. Strategic Planning for Student Communities in EU cities. Rotterdam, Ashgate.*