Naples Underground Line 6
Introduction

Line 6 of the Naples underground is an important element of the public transport railway network outlined by the Municipal Transport Plan (MTP) for the Metropolitan Area of Naples. Its target is to develop an integrated transport system that will be implemented on highly interconnected and structured networks in order to provide a balanced division of mobility between various transport means.

Naples’s town planning, territorial configuration, huge supply of railway infrastructure, intensity of transport demands, and traffic congestion levels show that the goal of the transport system is an integrated, powered railway network. The MTP’s fundamental idea is to build a network of railways, transforming the terminal sections of the individual historical lines of the regional railways covering the city (Ferrovie dello Stato, Circumvesuviana, Circumflegrea, Cumana, Funicolari) into underground railways, including new stations, new stretches and more frequent service.

The result is a network of nine metropolitan lines, or regional railways, acting as an underground network with a total length of 90 km, and with 98 stations and 18 large transport interchanges. The nine lines form three interconnected rings, which are crossed in various points by two transversal West-East axes.

Upon completion, Line 6 will be 11 km with 12 stations and 5 interchanges.

The operational frequency will be 4.5 minutes in the section Campegna-Municipio and 9 minutes in the section Porta del Parco-Campegna, transporting over 50 million passengers per year.
Line 6 contributes to increasing the degree of interconnection of the entire system, and configures itself as a segment capable of defining new network elements. It can be construed as a sub-system that can be subdivided into four parts with different implementation statuses:

- The first section in operation, which is Mostra-Mergellina, has a length of 2.2 km with four stations and two interchanges: Mostra–Campi Flegrei interchanges with Line 2 and Line 7, and with Line 2 in Mergellina.

- The second section currently being constructed, Mergellina-Municipio, has a length of 3.3 km with four stations, of which the terminus, Municipio, is an important interchange with Line 1, funicolare F2 and the sea station, from which the city is connected with the islands.

- The third section, currently under final planning, is Mostra-Campegna. It has a length of 1.1 km with a station – Campegna – and the warehouse-workshop, which covers over 83,000 square meters. It will be equipped with state-of-the-art maintenance systems, in addition to a control centre in order to receive technical and administrative professionals.

- The last section, currently under final planning, is Campegna-Porta del Parco. It has a length of 3.9 km, with three stations and 2 interchanges: in Acciaieria with funicolare F8, and in Porta del Parco with Line 8.
The planning procedure of Line 6 is the outcome of a series of meetings that led to the establishment of the Mostra-Mergellina section, and subsequently to its extension to Municipio station, and finally to the identification of the Warehouse-Workshop lot, which extends itself from Campegna to Mostra, thanks to the acquisition and valorisation of unused areas.

Therefore, it is evident how the Line includes elements of a different nature. The three line segments and its distribution area, where the warehouse is located, differ due to the type of line, the stations, and because of the features of the places they cross. The stations of the first sub-section, Mostra, Augusto, Lala and Mergellina are formally uniform, and those of the second sub-section, Arco Mirelli, San Pasquale, Chiaia and Municipio are very different from each other, crossing significantly appealing places in the city, clearly distinguishable and with peculiar features, such as Fuorigrotta, Riviera di Chiaia, Monte di Dio, San Ferdinando.

This area will be used as a warehouse-workshop, located inside an old military area close to Posillipo large coast, and has different features as well.

The new section, Campegna-Porta del Parco, with stations named Acciaieria, Città della Scienza and Porta del Parco, will define a new element in addition to the existing triple nature of the line.
Mostra-Mergellina

This station was opened to public in August 2007, and its section extends 2.2km, with 4 stations and train synchronisation of 10 minutes.

The stations, named Mostra, Augusto and Lala, were designed by architect Uberto Siola in compliance with the valorisation projects of the relevant squares, including large green areas and spaces to be used in a context consistent with the old style of the district of Mostra d'Oltremare. The Control Central Post, located in the area near Lala, was built in compliance with state-of-the-art ergonomic concepts and ensures the centralised management of the transport system, controlling all safety and security tasks. Mergellina station was planned by the architect Vittorio Magnago Lampugnani in order to provide a direct connection with the homonym FS station and Line 2 of the Underground. The station has two independent exits, of which one faces Parco Archeologico, where Vergil grave and Youth Hostel are located, and the other one faces the hydrofoil terminal.
Galileo, figliuolo del quondam Vincenzo Galilei di Firenze, del se
D’anni 70, costituto personalmente in giudizio, ed inginocchiato avanti
Voi Eminentissimi e Reverentissimi Cardinali, in tutta la Repubblica
Cristiana contro l’eretica pravità generali Inquisitori; avendo d’anni
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General performance of Mostra-Municipio system

- operation frequency: 4.5 minutes;
- maximum transport capacity: 7200 pphpd;
- 154,000 passengers/day;
- 46 million passengers/year
- operating speed: 28 km/h;
- three-vehicle trains: (3 drive units);

In order to satisfy any future increases of the transport demands, Line 6 system is technologically prepared for:

- maximum operating frequency: 3 minutes;
- maximum line transport capacity: 11,400 pphpd;
Mergellina-Municipio

This section is 3.3 km long with 4 stations. It will extend the public operation to Piazza Municipio, which will be connected to Campi Flegrei interchange through Riviera di Chiaia.

The line gallery was built on a dummy hole basis with a TBM - EPB shield, which ensures safe, expedient excavation and containment of landslides and distortions to the ground in order to avoid damages to the existing infrastructure. The first part of the section, which measures 1.6 km from the front part of the shield to Piazza Vittoria, is made with melted materials on layers.

This part extends from the buildings located in Piedigrotta to largo Torretta, and subsequently covers Riviera di Chiaia.

The second part of the section is 1.4 km long and extends from Piazza Vittoria to piazza Municipio. It is built in tuff and it goes under important buildings until it reaches piazza Municipio.

In a project with such important and technical work and the presence of delicate manufacturing operations, geotechnical monitoring plays an irreplaceable role in ensuring safe preparation of work without any significant inconveniences to the infrastructure and urban areas.

Therefore, an advanced data acquisition system has been developed. It maintains control of vertical and horizontal movement of points located on buildings, on land, and underground, as well as movement between the opposite sides of damaged buildings and/or manufactured products, and forces action over structural elements, including windbracing of excavations and anchorages in between places in deep points of land and levels of the water-bearing layer.
Arco Mirell station is located along the axis of Riviera di Chiaia. It ensures access to one of the most important residential, touristic and environmental areas of the city.

The project, performed by architect Hans Kolloff, shows the realisation of a singular and balanced glass pavilion, which, thanks to its light and linear steel structure, reflects the design of the large universal expositions of the Nineteenth century.

San Pasquale station is located close to the Aquarium pavilion and the historical building of Villa Pignatelli, serving mainly residential and commercial users. The project, implemented by Boris Podrecca, realises a spatial and underground integration, characterised by a large metal shell, which is completely released through the perimeter structures.

This is like a giant bubble between the lateral walls, covered by modular panels with azure colours that symbolize the presence of sea.

Municipio station, whose project was realised by architects Alvaro Siza Vieira and Eduardo Souto de Moura, shows the contemporary presence of two stations. Line 1 is the deeper one, whereas Line 6 is placed crosswise to Line 1. This station acts as an important interchange between the two lines, achieving a fundamental relationship between the metropolitan network, commercial, residential and tourist areas of the city.

The station features basic but “poetic” finishes, such as the conservation of the textures of wooden bodyworks on concrete surfaces, marble slab textures of rough staggered bricks, stones and white plasters characterise the style of these great Portuguese artists, who, by signing this project, achieved their goal to combine the archaeology of the old city found during the work with the restoration to new usable spaces and paths connecting the city with the international transport networks.

The opening of Municipio will provide the transport of 7,200 pphpd, or 154,000 passengers/day and 46 million passengers/year, through an operational frequency of 4.5 minutes between trains.

Chiaia station is in the heart of Chiaia district and was conceived by studio PROTEC (architect Siola and associates). It is situated vertically between the square Piazza di S. Maria degli Angeli and homonym street, with a difference of around 40 m from the square level to the platform level. The architectural structure of the plan ensures, through the presence of a helicoidal path, the interconnection between the square surface and the underlying mezzanine level.

A steel and crystal segmental arch is placed to cover the entire plan, which unifies and enhances the spacial image of the entire station’s architecture.
The warehouse/workshop facility in the area of the old military Arsenal

The final project will cover the West area of the city for the construction of the warehouse/workshop, which will be built in the area of the old military Arsenal located in Via Campegna. It will feature the new station of Campegna, which will serve the large district of Cavalleggeri d’Aosta.

The warehouse will be built on an area on 83,000 square meters in order to accommodate up to 50 driving units (which are sufficient for a possible line development until Posillipo), and will be fitted with a state-of-the-art PV plant capable of producing up to 0.5 Megawatts. A green area with around 1000 square metres to be used by citizens was also prepared.

The project includes the removal of plants and the polluting agents that may be located on site, by implementing removal & ecological-environmental improvement actions pursuant to the outcomes of the ecologic survey campaign that will be conducted in agreement with the Ministry of Environment. These actions are focused on the definition of the contamination status of the land and underground water matrices in relation to the production activities performed in the past.

Within the framework of mitigating the impact of actions in accordance with town-planning instruments and environment-protection obligations, the environmental improvement project is based on three parallel criteria:

- restoration of the natural profile of the areas at the foot of the hills;
- all-embracing system between the vegetation system and the urbanised areas, and relationship between the tree system and the structures of the work to be realised;
- mitigation of the impact on the indispensible structural works, which will be realised for the containment of the hillsides included within the perimeter of the concerned area.

In order to use a part of the square in perfect safety conditions, the execution of important mitigation actions on the hillside and foothills was scheduled, combining the needs of stabilisation and consolidation of the hill with the naturalistic interest of the landscape.
Campegna-Porta del Parco

The extension of the line in the area of Bagnoli/Coroglio was proposed with the objective of valorising the areas that already accommodate important urban improvement work in accordance with the current town-planning procedures. The project was developed in cooperation with the surface settlements in the area, as well as with the objective of ensuring the connection between the future urban area and the interchange of Piazza Municipio.

The three stations identified by the project and designed by Hitaka Architettura are the following:

- Acciaieria, located between Parco dello Sport and the urban park area, which correlates the natural element of the hill, the monumental element of the steelwork and the vocation of the area to be used as residence and service sector;
- Città della Scienza, the central part of the section, located in a place with strong natural and cultural features;
- Porta del Parco, line terminal, which acts as a real ‘place of connections’, both urban connections, which is located between the district of Bagnoli, its area and the park, and network connections, as it is conceived as an interchange station with Line 8.
The technological plants

Line 6 is a typical railway system that acts as an underground light rail system according to the provisions of the standard UNI UNIFER 8379.

The Automatic Train Control System is implemented in a Control Central Post that manages operations and maintenance and to which the safety, surveillance and front office services refer. The fail-safe microprocessor signalling system is configured according to the highest standards used in the most recent undergrounds in Italy and abroad, and is dimensioned in order to ensure an approximate frequency of 3 minutes.

The train traffic is managed automatically with respect to the pre-arranged operation schedule. Any divergences from the agreed times are corrected by using appropriate operation adjustment strategies, which are transmitted to automatic on-board driving devices in order to ensure the utmost respect of time schedules.

The state-of-the-art driving units have a length of around 39 m, with large interconnecting spaces between the drive cabs and the bodywork at the two sides. They are constructed by 4 bodies distributed over 5 bogies, of which 3 are motor bogies, intended to improve the dynamic behaviour and control noise and vibrations, giving passengers the utmost comfort. The transport capability of each unit is 300 passengers, and trains will circulate in double composition.
The structure is built with light alloy, in search of the best compromise between lightness and structural resistance, with steel reinforcements in the areas where bogies and body sides are located.

The braking system is electro-hydraulic and uses the most advanced solutions, ensuring, in full compliance with safety requirements, the choice between electro-dynamic and energy-saving braking in any operating condition.

The electric propulsion equipment is mainly composed of two variable-voltage and variable-frequency inverters/converters, one inverter for each motor bogie, each of them feeding two asynchronous traction engines.

A unique integrated system is scheduled for control and supervision. This system supervises the train functions using an off-centre architecture, both from the topographic and functional point of view, which is also prepared for the remote coupling of two trains. The communication network includes two separate communication systems: the MVB (Multifunctional Vehicle Bus), which interconnects the devices inside the train, and the WTB (Wire Train Bus), which ensures the data exchange between two trains is coupled to form a single train.

The vehicles are fitted with modern equipment for Automatic Train Protection and Automatic Train Operation functions, wireless data communication systems and a radio-digital system, which ensures the transmission of high-reliability information.
The SCADA automation system ensures the control of all feeding systems and accessory station plants, ensuring fast reconfigurations, diagnosis and maintenance of the components.

Modern optical-fibre integrated communication systems provide a network of phone connections, data and images, which control the proper operation and provide information to the public, giving passengers a high degree of safety both inside and on-board.

The feeding system schedules the primary distribution at 20 kV from electrical substations, which feed the contact line at 750 V DC and perform the secondary distributions through MV/LV stations substations fitted with diesel emergency groups and an Uninterruptible Power Supply (UPS).

The construction of the massive equipment system on fluctuating slabs ensures the minimisation of noise and vibration. This is a critical requirement for a transport system in an urban environment with a historical and town-planning importance.

The ventilation systems that were developed in order to face any emergency situation on-board and inside the stations, in coordination with detection and shutdown systems.

The primary ventilation system in the tunnels was developed in order to ensure the utmost safety and reliability and the best quality of life in populated environments in case of fire, and to minimise (even further than the limits set forth by the mandatory requirements) the noise outside the ventilation rooms.

The passenger movement systems are planned for the total demolition of any architectural barriers, and the paths for sightless people extend outside of the station environment and are coordinated through the pedestrian crossing ways, providing access to the interchanges of the transport system.

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The four underground stations in the Mostra-Mergellina section of Line 6 combine the realisation of stations with the creation of new city art places. This project was developed as a collaboration between architecture and art that’s aim is the valorization of the works of selected groups of significant artists that belong to the national and international artistic heritage and that contribute to the architectural heritage of the underground stations that are under construction.

Mostra station accommodates three mosaic works of Mario Sironi, who is a great author in Italian art history. In three polychrome mosaic works, he creates a successful and synergic combination between the Second World War architectures, the building of the Faculty of Engineering and the places of the scientific culture of the city, historically localised within the university area of Fuorigrotta. The station city is historically an installation of the Neapolitan artist Gianni Pisani, the new photographic collection of Pino Musi that develops its pictures between images of unpublished graphic documents of the archive of the Post Office building realised by the architect Vaccaio, and four suggestive photographs depicting the area of Mostra d’Oltremare taken by Gabriele Basilico.

Augusto station incorporates the important testimony of young artists, such as Matteo Fraterno, Cristina Crespo, Luisa Rabbia and Carmine Rezzuti, with their polychrome mosaic panels, as well as the photographs of the Turinese artists Gianfranco Botta and Roberta Bruno located near the platform. Furthermore, there are the four box lights by Franco Scognamiglio, which show a synergy between the architectural spaces of the station and the surprising and diversified language of photographic art.

The actions shown in Lala station through the work of Nanni Balestrini, located at the beginning of the station Gangways, create an ideal aesthetic and literary entrance, proposing a real physical, visual and mental reading of the station spaces.

The gangway shows the work of five photographers: the work of Monica Biancardi, which focuses on the representation of the human pathos in the picture of a veiled woman, the two works of Luca Campigotto depicting night views of industrial and port areas, the five photographs of Vincenzo Castella, which look into the surprising urban scenery of the outskirts of the contemporary Naples, as well as the photographs of Salvino Campos and Ousmane Ndiaye Dago, which look into the ethnical scenery of overseas territory.

It is also important to mention the huge work of Gerhard Merz for Mergellina station, where the great escape of colours, realised in a mosaic along the walls of the stations’ mezzanine floor, announces the initiation toward an aesthetic experience into the unknown places of the firmament, reminding one of the perspective views of Giovan Battista Tiepolo.
The work is composed of 12 photographic panels included in polycarbonate boxes whose size is approximately 116 x 146 cm, and 4 photographic panels included in polycarbonate boxes whose size is approximately 117 x 150. The pictures are both black-and-white and colour on a special adhesive paper on a cloth-lined supporting bottom. They depict particular architectures, sculptures and graphic signs of the futuristic movement in Naples.

Mostra station
artist: Marie Sironi

The work is composed of 3 panels in polychrome mosaic, performed in an opus incertum style with glass mosaic of different shape and width, laid to supports of dibond metal panels. The polychrome mosaics depict human images, architectures, landscapes and animals in emblematic positions, which are typical of the artistic repertoire of one of the most representative artists of the Italian twentieth century. The main panels is around 6,00 x 3,00 m, whereas the two side panels are 2,00 x 3,00 m.

Augusto station
artists: Botto e Bruno

The work develops on the walls of the link between mezzanine floor and platform for the entire length of the gangway, and has a height of approximately 2.20 m.

The work is on colour photographic print in adhesives on PVC, glued on a steel plate, and protected by a special varnish film. It depicts human architectures and images within the landscape of urban outskirts of the contemporary cities.

Mostra station
artist: Mario Castelli

The work is composed of 2 white-and-black photographic panels whose size is around 2.40 x 1.80 m. The black-and-white photographs depict four bodies of central African women seen with their backs turned and covered with mud in the desert, taking part in a type of tribal dance.

Lala station
artist: Gerhard Merz

The work is composed of 2 photographic panels whose size is around 3.80 x 3.50 m and 1.60 x 1.40 m. The first colour scenery depicts the prow of a boat in a port with an industrial landscape, whereas the second one shows a particular structure of industrial building, with the presence of three chimneys close-up. Both views include a night atmosphere, offering interesting artificial illumination overviews.

Lala station
artist: Luca Campigotto

The work is composed of 2 photographic panels, whose sizes are around 3.80 x 3.50 m and 1.60 x 1.40 m. The first colour scenery depicts the prow of a boat in a port with an industrial landscape, whereas the second one shows a particular structure of industrial building, with the presence of three chimneys close-up. Both views include a night atmosphere, offering interesting artificial illumination overviews.

Mergellina station
artist: Osmnane Niliya Diop

The work is composed of 2 photographic panels whose size is around 2.40 x 1.80 m. The colour photographs depict a man executing a typical dance of South American populations.

Augusto station
artist: Vincenzo Castella

The work is composed of 5 photographic panels installed in a polycarbonate box, whose sizes are approximately 1.80 x 3.00 m. These colour photographic works, performed on a special paper, show details of architectures and views from above of Naples buildings interconnected to Fuorigrotta.

Mergellina station
artist: Monica Biancardi

The work is composed of one photographic panel whose size is around 1.40 x 2.00 m. The black-and-white photographs on a PVC structure with an underlying Box Light shows the dramatic woman’s face, covered by a veil, while letting out a scream.

Lala station
artist: Stefano Campos

The work is composed of 3 photographic panels whose size is around 2.40 x 2.00 m. The black-and-white photographs depict a man executing a typical dance of South American populations.

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Grantor
Municipality of Naples
5th Central Administration for Infrastructures

Operator
Hitachi Rail STS

Realisation of civil works
Temporary Business Enterprise for Line 6
Agent: Paolo De Luca Costruzioni Generali
Principal: Costrade, Consorto Stabile Infrastrutture (Impresa e Gruppo Maltauro), MN6 scarl (Astaldi, A. & I . Della Morte, Costruire, GDL, Itiner, Impresa Pizzarotti & C., Impreglio, Moccia Irme, Consorto Stabile Infrastrutture, Pianini Lavori )

Project coordination and execution of civil works
Metropolitana di Napoli SpA
The works are performed with the contribution of the European Union, Regione Campania and the Ministry of Infrastructures and Transports

Architects
The operating section: Mostra-Mergellina

MOSTRA STATION
Luigi Milano, Uberto Siola, Federica Visconti
LOCATIONS OUTSIDE PIAZZALE TECCHIO
Luigi Milano, Uberto Siola, Federica Visconti

AUGUSTO STATION
Luigi Milano, Luigi Pisciotti, Dante Rabitti, Uberto Siola, Federica Visconti
LOCATIONS OUTSIDE LARGO VENIERO
Luigi Milano, Uberto Siola, Federica Visconti

LALA STATION
Luigi Milano, Luigi Pisciotti, Dante Rabitti, Uberto Siola, Federica Visconti
LOCATIONS OUTSIDE PIAZZA LALA
Luigi Milano, Uberto Siola, Federica Visconti

MERGELLINA STATION
Luigi Milano, Luigi Pisciotti, Dante Rabitti, Uberto Siola, Federica Visconti
LINE 2 CONNECTION and EXTERNAL LOCATIONS
Vittorio Magnago Lampugnani

The section under construction: Mergellina-Municipio

ARCO MIRELLI STATION
Hans Kollhoff
SAN PASQUALE STATION
Boris Podrecca
CHIAIA STATION
Uberto Siola
MUNICIPIO STATION
Alvaro Siza Vieira and Eduardo Soufo

Section Campegna – Porta del Parco (final project)

CAMPEGNA STATION
Uberto Siola

ACCIAIERIA STATION
Hitaka architettura

CITA’ DELLA SCIENZA STATION
Hitaka architettura

PORTA DEL PARCO STATION
Hitaka architettura

Artists
Mario Sironi, Marisa Merz, Gianni Pisan, Pino Musi, Gabriele Basilico, Matteo Paterno, Cristina Crespo, Luisa Rabbia, Carmine Rezzuti, Gianfranco Botto e Roberta Bruno, Franco Scognamillo, Nanni Balestrini, Monica Biancardi, Luca Campigotto, Vincenzo Castellani, Salvino Campus and Gusmane Nlaye Dago, Gerhard Merz

Pictures
Pepe Avallone
Oreste Lanzetta
Pino Occhionero
Sergio Riccio
Giuseppe Scognamillo

Art direction
Toni Di Pace.com
Hitachi Rail STS
Via Paolo Mantovani, 3-5
16151 Genoa
Italy

sts.hitachirail.com